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Contents

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Governance

During my couple of years in the Board of the previous Transit NZ, I had cause to question the real role of that Board and our governance role.

In my mind Transit NZ was entrusted with the development, care and performance of a major national asset – the New Zealand roading infrastructure. Too often I felt that the Board was reduced to being a rubber stamp for Government directives.

This rubber stamp function is a trap that can be easily fallen into. When this occurs, the governance function becomes limited to finessing the details: either petty administrative matters or carrying out agendas determined by others, such as purchasing land to build roads or sanctioning the procurement of construction work after excellent preparation work by TNZ staff.

There was little or no flexibility or empowerment for the Board to actually determine how to plan construction and management of the State Highway system. An important function of TNZ – that of periodic and regular maintenance of the assets – was curtailed by budgetary strictures, while plans progressed for new and extravagant projects, often to secure electorates' votes or meet political aspirations.

Such were the cases of Auckland's 'Northern Gateway', otherwise known as the AlpurtB2 motorway (more about this project in this issue), which was processed on the strength of a positive benefit/cost ratio... based upon Aucklanders' holiday traffic counts. And the second Tauranga Bridge, in the 'must win' electorate of another politician.

Fortunately, a change of government may have put paid to the 2 billion dollar (plus) Waterview tunnels in Auckland, a white elephant whose function can be performed on the surface, at a cost which our country can afford.

It is hoped that the current government can appoint business-like SOE boards, truly empowered to carry out their duty of managing the country's assets, with the interests of the Nation at the core.

In the current state of depletion of the country's coffers, and given the need to

Ernesto Henriod, Editor

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generate jobs with less money, highway maintenance is likely to be the type of investment that will create most jobs, dollar for dollar... and the SH network needs it.

Optimising Procurement: the Non-price Factors

Transit had an excellent professional team in its staff… and I hope most of the talent has transferred to the NZ Transportation Agency. One of the very important functions they performed was that of optimising procurement, looking for best value, not just for lowest price. True, lowest price is a criterion that can be applied to simple or low-cost projects for which there is a good supply of well-qualified contractors that will ensure competition amongst peers and an almost assured satisfactory completion.

But very large and/or complex projects, projects which demand special skills or can be tackled by a number of different ways require a different approach, where the non-price factors must be taken into account and included in the evaluation of the tenders. In some cases, the non-price factors can in fact lead to lowest cost, when contractors are permitted to tender on the basis of alternatives to the design and specifications produced in-house by the Principal or by its consultants.

Reliability and track record in similar projects are perhaps the first to be considered, followed closely by the quality of the team to be put in place for the complex job. But beware! Well-known firms can present their case on the strength of an A-1 team, which later vanishes… The World Bank suspended an international firm of consultants who, in one case, had put together a 'team' which included two dead civil engineers, and a third professional who had not been approached, and was not available. In another project, the same firm substituted seven out of eight top professionals with lower-status personnel, after it had been selected for the job. This can also occur among contractors, and is particularly critical when highly specialised technical skills are necessary or when the performance of the top project management team is paramount to overcome serious challenges.

The availability of specialised equipment can also be a determining factor. Tunnel boring machines, for example, are now in short supply and have a long lead period before new ones can be put in place; a contractor having access to a suitable TBM can in fact save a considerable amount of time in the execution of the work. Thus, a realistic time saving offered by a bidder also comes into the picture as a non-price factor leading to the lowest actual cost.

But perhaps the factor that requires most ingenuity is that of putting forward alternative designs or construction systems that save money while retaining the basic performance characteristics of the project and saving time and money. This is usually the case in bridge construction, where multiple types of span or different construction approaches can produce the required structure. I was impressed, for example, with the ingenious construction system being used for the foundations of a major bridge on estuarine silts: the piers are based on the underlying rock by placing tremied concrete (from the bottom up) on a 'virtual' caisson created by excavating the cylindrical shape and substituting the excavated silts with a bentonite slurry, which is recovered, treated and used further along the job.

Alliancing is now used more often for large and complex projects, as it can lead to overall time and cost savings and satisfactory performance. A prime requirement for the 'virtual' entity that will run a successful construction job is that all contributors to the team – owner, consultant, contractor – provide top personnel, experienced in the type of project and capable of performing at the management levels needed by the Alliance. This implies capability and empowerment to take decisions on behalf of the contributing principals. A further insight into the non-price factors in an Alliance can be gleaned from Brett Giddon's article on the Northern Gateway Alliance, in this same issue.

How does one quantify and evaluate the worth of these non-price factors? In some cases, a points system is used, with price being considered as part of the overall marks; in others, particular factors can lead to discounts of the bid price for comparison purposes.

The environment, innovation, constructability, life cycle costs and benefits, durability and maintenance, use of local labour and materials, and so on… it's a long list of non-price factors in tender evaluation. It is a long story, worthy of telling in full: I sincerely hope someone will rise to the challenge and write us a substantial article on this potentially controversial subject. Controversial, only if not applied objectively in the selection process, along well-defined conditions of tender.

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Embodied Energy and the Present Value of Carbon: Time for Lifecycle Thinking

by Ross Copland

Introduction

Embodied energy is the energy required to make a product which includes 'raw material extraction and processing, energy production, transportation and product manufacture – aka cradle to gate' [1]. Buildings are material intensive creatures. The World Business Council for Sustainable Development reports that buildings consume a whopping 32% of all resources, 40% of all energy and are responsible for 40% of global landfill waste [8]. The energy embodied in these consumed and dumped building materials represents a significant mass of emitted carbon equivalent greenhouse gasses. Figure 1 illustrates energy use in the building lifecycle.

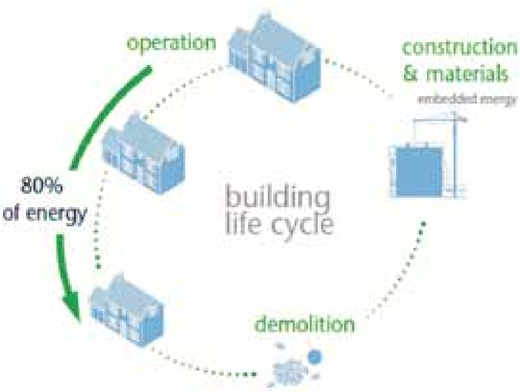

Figure 1: Energy Lifecycle in Buildings (WBCSD , 2009)

New Zealand's recently announced greenhouse gas emissions reduction target of 10% - 20% below 1990 levels by 2020 will require a major effort by the building industry given the significant and growing energy demands of the sector.

Operational Energy

There is a possibility that the pursuit of reduced operational energy in buildings, with no regard for embodied energy, may be a driver of unintended outcomes when it comes to reducing lifecycle greenhouse gas emissions. The 2009 Green Star Office Design tool's most heavily weighted credit is based on the reduction of energy consumption in the building for the stated purpose of reducing greenhouse gas emissions. Accordingly, designers have aimed to maximise Green Star ratings by targeting reductions in operating energy consumption. This is often achieved through greater use of energy intensive building materials – one of which is glass.

Dematerialisation can be expressed as "the reduction of the throughput of materials in human societies" [2]. It refers the total production and use of materials and can be referred to in absolute terms (society as a whole) and in relative terms (an industry sector) [2]. In an age where the cell phone has reduced from a 1 kg house brick to something more like the size and shape of a credit card, it is difficult to justify the reverse trend occurring in certain parts of the building sector.

Since 1973 the average New Zealand dwelling has increased from 110 m^2 to 197 m^2. Over the same period the average household size has decreased significantly meaning that the average New Zealander in 1973 had 32.5 m^2 of living space compared with 73 m^2 in 2008 – an increase of a staggering 125%. This has had a profound effect on both embodied and operational energy of New Zealand houses driving up the capital build cost to the point where the 2008 Government declared a housing affordability crisis [3]. Perhaps on a square meter for square meter basis (excluding land), houses today are actually relatively cheap. It seems our perception of adequacy may have been the true driver of diminished affordability.

Is the same growth in space demand true of the commercial building sector? At least for office space, it would seem not. A recent study of Auckland office space utilisations demonstrates reducing space per employee from 21 m^2 in 1998, to 18.67 m^2 in 2000, and just 15.6 m^2 in 2008. This includes all reception areas, meeting and board rooms [4]. A reduction of over 25% in the past decade indicates the commercial market is more aware of spatial needs and has targeted value accordingly. This trend is likely driven by greater use of needs assessment tools and a better understanding of the 'functional unit' office space provides. Owners of offices are also less prone to the effects of having to keep pace with the Joneses.

Occasionally I hear people rattle off energy consumption figures from something they read somewhere – many of which tend to imply that embodied energy is negligible compared with operational and therefore of little concern. With CO_2 emissions from cement production currently estimated at around 5% of the anthropogenic global total (more than all air travel combined), the lack of an embodied energy measure in Green Star rating tools must be difficult to comprehend for those preparing sustainable transport plans and installing video conferencing to reduce air travel – the sum of which may produce a fraction of the CO_2 savings on offer through the use of low energy cement for example.

An illustration of the importance of understanding lifecycle energy is found in low-e glass. Low emissivity glass has advanced coatings applied to it which can potentially double the insulation value of the glazing unit. What isn't commonly understood is that the manufacturing rejection rate for low-e glass is as high as 50% due to the difficulty of applying the advanced coatings. This causes huge quantities of glass to be ground and re-melted at the manufacturing plant resulting in very significant wasted energy (3.8 x 1010 Btus) in the low-e glass manufacturing process [5].

Lifecycle Energy and CO_2

Engineers are very good at optimising a system for a given variable. We need to start optimising for whole life cycle energy and CO_2 emissions rather than operational alone. The building material manufacturers recognise the importance of embodied energy. Anyone travelling up Auckland's southern motorway over the past 12 months will have bypassed advertisements from both the Cement and Concrete Association and NZ Wood – advertisements which have concentrated on the embodied CO_2 of these important building materials.

The steel industry is very interested in CO_2 as well. In 2008 Steel Construction New Zealand Inc (SCNZ) published a report comparing the embodied energy of three competing 10 storey structural systems comprising mainly concrete, mainly steel and a combination of the two [6]. This research uses a dual lifecycle method of analysing the embodied energy in the structural system – a methodology which in this case favours the steel example due to the greater recycling rates applied to the steel case. A full lifecycle assessment of the competing systems which also assessed their respective effects on operational energy consumption would be a more robust and useful comparison. This study highlights the importance of the assumptions made in the calculation of embodied energy – one of the reasons why the New Zealand Green Building Council has steered clear of this issue to date [9].

Interestingly a mainly timber option was not considered in the SCNZ study. Until recently timber has not been considered a viable option for buildings above roughly 6 storeys in height. Recent work at the University of Canterbury has changed that for good.

In 2008 the Structural Timber Innovation Company (STIC) was founded promising to develop new and exciting uses for timber in buildings. One of these new uses is in multi-storey buildings. A recently constructed prototype building consisting of post-tensioned LVL (Laminated Veneer Lumber) beams, columns and walls has the potential to deliver timber buildings of 20 storeys or more according to Professor of Timber Design, Andy Buchannan.

An actual 6-storey, 4250 m^2 building at the University of Canterbury was analysed in terms of whole of life (60 years) energy consumption assessing the contribution of embodied energy in competing structural systems – but this time the timber system described above was considered along with the incumbents – concrete and steel [7]. The outcome of this research showed that embodied energy is important. Using New Zealand-specific embodied energy figures from researcher Andrew Alcorn, the study demonstrates that the total embodied energy between the 4 structural options for this real building averaged 23% of the total (operating energy consumption was 77%). In terms of CO_2, the results using Alcorn's coefficients demonstrated that on average 7% of the entire lifecycle CO_2 equivalent emissions are embodied, while 93% are operational. The importance of embodied CO_2 is even greater if GaBi (world average) coefficients are used. GaBi coefficients place embodied CO_2 at a very significant 16% of total emissions over the 60 year lifecycle of the building.

This research example was taken a step further when Scion partnered with Victoria and Canterbury Universities in a report for MAF titled, Environmental Impacts of Multi-Storey Buildings Using Different Construction Materials [1]. This report is by far the most comprehensive and up to date study available on this particular subject in New Zealand. Scion has carried out the most recent Life Cycle Assessment (LCA) study on building materials. LCA is widely regarded as the most robust means of assessing competing systems.

The study [1] has the following key findings:

- Concrete, steel and timber buildings can all be designed to have low operational energy consumption of 85 kWh/m^2/year and within 3% of eachother;
- The contribution of embodied energy to lifecycle energy ranged from 6% for the 'timber plus' design to 13% for the steel design;
- The end of life assumption for the materials has a significant impact on the energy and global warming potential (GWP);
- Assuming limited end of life carbon storage, the 'timber plus' design has the lowest GWP with 11% of the lifecycle emissions versus steel at 23%;
- Replacing energy intensive aluminium architectural finishes and claddings with timber gives very significant whole of life GWP and embodied energy reductions.

Time Value of Carbon

I am very interested to understand how Present Value analysis, as used in calculating the whole of life return on an investment, could equally be applied to the lifecycle emissions of CO_2. Consider one tonne of CO_2 emitted in year one versus one tonne of CO_2 emitted in year 60 of the project lifecycle. I hypothesise that it is significantly more important to mitigate the tonne of CO_2 today than the 60th year tonne. The tonne in the 60th year is still very important, but less so than the tonne today. If this is indeed the case, then the importance of carbon emitted in year zero (pre construction in the manufacture of materials), must be relatively more significant than the same carbon emitted during the operation of the structure. This weighting, if quantified, could give rise to the Net Present Value of CO_2 in the whole lifecycle of a structure. I hate to think how difficult it might be to work out a discount rate! If we take a monetary example for the purposes of illustration, using a discount rate of 5%, $1 in 60 years time is worth just 5 cents today. My very limited understanding of climate change theory is that the rate of warming increases exponentially with increases in CO_2 – hence the hypothesis that the 'time value of carbon' is important. This theory could drastically change the way we look at the importance of embodied energy. If year zero emissions (currently approximately 16% of lifecycle total), are weighted at 5-10 times greater than average operational emissions, the lifecycle emissions picture looks vastly different indeed. Google 'time value of carbon' for some ideas which may seriously alter your impression of the importance time in relation to emissions.

Cutting out the Carbs

Concrete, the world's second most consumed resource after water and the most consumed man-made material, has significant potential to reduce its environmental footprint. Mainzeal recently used 5000 tonnes of waste glass aggregate in the construction of the new Lion Nathan brewery – much of which was used in the concrete. We are currently using concrete with 20% recycled aggregates and 20% replacement of cement with New Zealand flyash. Recent New Zealand research suggests that the recarbonation of concrete at end of life has the ability to reverse much of the CO_2 emissions resulting from calcination [10].

The steel industry is investigating ways to reduce the total steel required in buildings through a better understanding of material properties and through the use of high performance steel. A group was recently established to investigate ways that the metals industry can further reduce its carbon footprint in the light of Government and industry driven CO_2 reduction targets.

Summary

The embodied energy in building materials such as glass, concrete, aluminium and steel is significant in the context of the whole lifecycle energy used in buildings. In certain structural systems it represents more than 20% of the lifecycle energy. If the time value of CO_2 is considered, this embodied energy is even more important than currently calculated. Environmentally conscious designers can no longer ignore this important fact.

Furthermore, the building industry has the ability to significantly cut these embodied energy and CO_2 emissions through far greater use of timber, low energy cement, recycling of metals and aggregates – and those are just ideas from recent Mainzeal projects. There are hundreds more innovations with the ability to drastically cut embodied energy and emissions.

The industry needs strong incentives to implement these technologies more widely. The Green Star Design tools are a great example of where these incentives could begin. If New Zealand is to meet its emissions reduction targets, the incentives for low-carbon construction need to be implemented immediately. We have proven we can construct low-carbon, energy efficient, cost effective buildings. So let's get on with it.

Editor's Note
Ross has written a challenging article, as suggested by its title. It focuses on the life-cycle sustainability of buildings of all types, in terms of their carbon footprint, and presents important issues. We would welcome more discussion on this subject: our pages are open for letters or articles to further our knowledge of building efficiency related to their carbon significance. *EH*

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High Performance Timber: World First: Paul Blackler (Mainzeal, Southern Region GM), Mike Newcombe (PhD timber researcher), Ross Copland (Project Manager) and Andy Buchanan (Prof. Timber Design, UC) with the recently constructed post-tensioned LVL test building at the University of Canterbury. Mainzeal, CHH, NPI, Hunters, McIntosh, STIC and others made contributions to ensure the success of this exciting research project which has proven the technology for the use of timber as the primary structural system in tall multi-storey buildings.

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About the Author

Ross Copland is the Sustainability Manager for Mainzeal. He is a Civil Engineer experienced in building construction and research into construction materials, having won the 2008 Concrete Sustainability Award for his research with Holcim on the use of waste glass for aggregate. He was also Project manager of the Canterbury University Post-tensioned Timber test building. Internationally, Ross is the CEO of Engineers Without Borders (NZ) having worked in Africa and the Pacific Islands, providing sustainable engineering aid projects.

Tendering Right!

by Scott Palmer

So finally the tender documents have arrived. You pull them out of the envelope, a large thick daunting pile of white paper and you think, "Darn, here we go again, here comes the hard stuff".

Wrong!

If you're a good 'tenderer' and your bid team is up to it, a lot of that "hard stuff" will have been gone over already and you will be smiling, ear to ear, because you already know the answers to those 'daunting' questions. Most importantly, you know what the client wants.

Ideally, your bid/tender team will have already met the clients, understood their needs and wants, and have the clients' preferred solution in mind. Remember when you were young and sitting school exams? When you knew your stuff you would walk into the classroom with confidence turn the examination over, look at the question and start writing. And when you didn't know your stuff? You'd read questions twice, stare at the floor, scratch your head and do one of three things: write mumbo jumbo, panic or try to cheat! Tenders are like an exam that you need to prepare for, swot for, and pass. Because in this test there is usually just one winner, the more preparation and effort put in before the event, the greater your chances of success in the process.

Your Business Development, Sales and Account teams should know when tenders are due and there should be calendar of key dates held, at best, in your CRM (Customer Relationship Management system) or, at worst, noted on a calendar. If you are the existing contractor or provider, looking at further work with the same client, several processes should be followed:

- Contract end dates need to be communicated to the bid/tender team at least 12 months out so workloads and resources can be planned and managed (there is nothing worse than two big tenders hitting the desk at once).
- The existing account/relationships manager needs to be honest about the current status of relationships and, most importantly, highlight current key weaknesses with the contract.
- Assuming this is going on 12 months before contract end, you have 12 months to get the weaknesses sorted out and improve the relationship with the existing client. It may well be that multi-level relationships need to be introduced, to provide a better chance of success in retaining or winning the client.

- The Bid team needs to get close to clients and work towards developing fruitful meetings. Generally speaking, the more heads available to work through solutions the better. Brain storming and thought sharing usually result in the best outcomes. However, sometimes those closest to the client are blinded by familiarity developed in time, so fresh thinking and new eyes are always a positive approach.

If you're trying to win the business and you're not the incumbent, the best and most appropriate time to be gathering information is outside of the tender period. This is the time when Procurement Managers and those putting the bid/tender to market will generally talk free and openly about what their requirements are and I stress 'their requirements'. They're telling you what their needs are, so listen. It's not about what products and services you have; it's what they want and what they're looking for that you need to know, to best define your tender strategy.

In my experience, those dissatisfied with current providers will really open up and put as much information on the table as possible, to try to get a new solution that works for them: this is the time to listen and ask questions.

Assuming you are on top of your game, your approach should be underway around 12 months before the tenders due, with regular follow up calls and meetings (in true business development style) to cement your thoughts, gather additional information and enhance the new relationship. The client will generally appreciate your enthusiasm (just don't overdo it) and look forward to your formal response when the time comes, to see how you have assimilated all the information and turned into a solution.

Writing the document shouldn't be looked on as a daunting task. It's a project that needs to be managed. Good Bid Managers have both an eye for detail and on the big picture. They have to bring together various people, teams and thoughts and shape those variables into a simple to read and comprehensive written solution, backed by a solid presentation… for you to make the cut.

It can be a stressful, definitely time-consuming and often frustrating process. Bid Managers aren't there just to be your friend, they're there to win the business either by retaining your client or helping you hit your sales target.

The written document itself needs to address a number of areas:

- Are answers readable (avoid jargon)?
- Can we say more with less (over complicated)?
- Can we rewrite the answer for the audience?
- Are we telling the truth (can we deliver)?
- Is there consistency between divisions/products?
- Are we talking the same language?
- Is the message consistent (Bid Managers job!).

Big tenders need to be closely managed. The Bid team will farm out a number of areas of the document to relevant operational and support teams who are best suited to each question and then bring consistency to the response by either rewriting it or tweaking it with the audience in mind.

One point I cannot stress enough is the importance of highlighting benefits. Every company likes to stress the features of the great product or service it can provide, but the clients need to understand what benefits will accrue to them from those products or services. If you've done your home work and you know your clients business, you will be able to recognise exactly where your product/service will provide benefits with the greatest impact.

Assuming you are on board as a tenderer, the next step will be the presentation of your offer. This can get messy if there are an excessive number of people who want to attend. This comes down to who wants to be there versus who needs to be there. Bid Manager, Account Manager, Operations and a token senior company executive (e.g., General Manger/Managing Director) depending on the level and desirability of the contract, normally make up the party. All efforts should be made to find out who is attending from the other side, to evenly match the attendees from your company.

If you've made it through to the presentation you're in with a chance. Ensure you know who from your side will cover the questions you may be asked. Prepare, and prepare well. This may mean rehearsing for the presentation several times. Spend some time covering answers to weak areas of your proposal as this is where you're likely to get hit by the client: define who from your side will respond and in what terms.

Lastly, present with confidence, and present like you're there to win. If you think you're showing up to make up the numbers, you shouldn't bother going. No contract or tender is a sure thing until the race has been won, and contract has been signed.

Good luck!

About the Author

Scott Palmer is a Sales and Marketing specialist with a Master's degree in Business from Massey University. He has worked in his speciality for over 15 years, for some of the largest companies in Australasia and elsewhere, with considerable success. Scott is Director of Crunch Marketing, a specialised firm assisting our Industry.

A Reflection on New Zealand's Largest Haulage Operation

from Bernard Hill's Notes and Photographs

In the context of proposals for investment in national infrastructure in New Zealand it is timely to review the logistical requirements for large-scale haulage operations. This is an area in which there is some considerable experience in New Zealand. Take, for example, the construction of the Motunui Methanol plant in Taranaki during the early 1980s.

At the time of construction, this plant was a first-of-its-kind, and one of the largest methanol plants in the world. A shortage of specialist tradesmen in New Zealand during construction meant that, uniquely, the design of the plant involved a modular pre-assembly concept with major units and piping systems constructed and pre-assembled in Japan. These pre-assemblies were then transported to Port Taranaki by ship and hauled by road to the site, some 26 km away.

The total job involved the transport of some 187 preassembled modules, weighing a total of 27,320 tonnes. The 187 modules consisted of heat exchangers, air preheaters, convection sections, compressors, turbines etc. The dimensions and weights of these modules are an indication of the scale of the operation that was undertaken.

- Average Weight 164 Tonnes
- Heaviest Module 592 Tonnes
- Widest Module 12.5 Metres
- Longest Module 39.5 Metres
- Tallest Module 23.6 Metres.

Dales Heavy Haulage and Mogal-Rigging were contracted to not only undertake the heavy haulage from the port to the site but also to erect the plant. The off-site aspects of the operation were coordinated by project engineer Bernard Hill (now a Project Director for Hawkins Construction). At the time, his role included responsibility for the engineering of loads, coordination of and liaison with the authorities, and the establishment of hauling criteria, procedures and schedules. We are indebted to Bernard for having retained the original project documentation from the job. A review of how this was achieved illustrates the vast amount of planning and the significant level of engineering needed to undertake this type of major haulage enterprise.

Engineering and Testing

Firstly Bechtel, the Motunui project engineers, required Dales to demonstrate that the concept of road transporting modules of such vast size and weight was possible. Route simulation tests included a full-scale test run, hauling 224 tonnes of concrete along the intended route. Monitoring of surfaces and pavements occurred along the full length of the route, with results closely matching the calculated predictions.

An interesting side issue was the behaviour of the hydraulically suspended trailers and in particular the ground level effects of externally induced hydraulic loads. Designers of the preassembled modules needed to take into account the means by which they would be transported, in accordance with agreed engineering principles. However, applied forces

Figure 1: Route simulation tests through New Plymouth streets, December 12/13 1981

Figure 2: Load P0203 passes the Moturoa shops

such as transverse and longitudinal tilt, hydraulic compensation over hills, and the effects of wind and braking were not considered in the design by the vendor teams and instead became the responsibility of the haulage contractors.

To meet these requirements, Dales were required to supply transport support systems to interface between the trailer and the load. Steel beams were supplied for supporting the modules, and a load distribution support structure for the large rectangular shaped air preheaters was created. Liberal amounts of ballast were used to alter centres of gravity and increase hydraulic stability.

Another issue was bridge performance under the same dynamic loads. The major concern being the ability of the bridge structural systems to redistribute the uneven wheel set loads. In order to confirm the adequacy of the bridges to sustain load the design performance parameters of the bridges were reviewed by Professor Stephen Harris of Cambridge University. With the benefit of the specialist review, workable approaches were developed and accepted.

Ministry of Transport and Ministry of Works requirements

The MOT specified conditions of travel, requiring a 6 week review / approval process from head office for each journey, after which a permit would be issued. Accordingly, a seven-weekly schedule was drawn up. Policy was established by the MOW and MOT for convoy loads, hours of travel and illumination of the haul train. Applications for permits required much data,

Figure 3: Load P0106 climbs the 4% grade at Gill Street

including general arrangement drawings showing details for the load, trailer prime movers, support systems, tie downs and axle loads. Stability calculations were also required. Permits were later required to also include calculations showing the effects of wind, tilt and centre of gravity eccentricity on axle loadings. This resulted in significantly increased engineering input and generated large amounts of paperwork.

Local MOT officers would issue permits, schedule liaison meetings and check piloting forms before each haul began. They would also confirm that clearways were actually clear and police this, where necessary. Front and rear traffic police officer escorts deviated the traffic flow down side streets, or ensured vehicles moved out of the haul train's path. While mostly successful, on six occasions during night hauls drunken drivers ignored traffic officer signals, twice hitting the trailer or load.

The Ministry of Works department were also present during hauls, to monitor the effects of the expected dynamic loads on the bridges. Instrumentation such as strain gauges was installed to monitor this. MOW staff also carried out level checks when the loads were stopped on bridges, during the testing phase.

Council and administration authority considerations

The New Plymouth City Council (NPCC) was concerned about damage to utilities and road

Figure 4: The 622P trailer traverses the Port silo corner - the uneven road profile results in full extension and compression of the hydraulic rams

Figure 5: Port storage for P0211

Figure 6: P0106 approaches Gill/Hobson intersection - the tightest corner on the haul route

surfaces. Severe restrictions were placed on loadings and tyre pressures. These restrictions were eased once operations began. Council surveyors marked the outer extremes of where the trailers should be on the roads when deviations from the centreline would be necessary, to assist drivers in picking the optimal path.

Two council employees escorted all hauls to ensure permit conditions were adhered to, replace moveable traffic signs and water sharp corners to reduce scuffing or tearing of asphalt. Specified tyre pressures were also stipulated to reduce damage to road surfaces. Another council crew followed the operation removing clearway signs. For loads over 200 tonnes a council engineering officer walked behind checking the road for signs of damage.

Within city limits the council could specify at what times the haul could occur (often at night), subject to MOT approval. However, once the haul train exited city limits the National Roads Board (NRB) had authority on state highways. They therefore would determine allowable travel times on these roads, again subject to approval by the MOT.

Discrepancies in allowable travel times existed between the NPCC and the NRB, which disrupted plans for transporting modules. Dales Heavy Haulage established hauling period charts and submitted them to the respective authorities for review and approval. This resulted in both agencies coming to agreements on acceptable travel times.

In addition to the above, permits were required by the Taranaki Harbour Board to ensure trailer and axle loadings did not exceed the maximum permissible load for each wharf. New Plymouth City Electricity Department required that personnel from this department were also present to monitor the very wide loads, and would turn off power supply through 11 KV lines should clearance fall below a distance of 1 metre.

In all, this became a significant organisational task with every regulatory authority (both central and local) needing to ensure that their 'piece' of the action was administered to the fullest extent possible. The project organisation included an operations controller to assist permitting activities and liaising with administrating authorities (as the language of the day expresses it!)

The Haul Itself

Determining an acceptable route needed to take into consideration road width, road strength, bridge widths, bridge strength, corners, hills, effects on road surfaces, the presence of lay-bys, and obstacles including overhead wires, signs, trees, telephone poles and other utilities. Six bridges were present on the route, three of which were upgraded to cope with the immense loads. The other three were completely rebuilt.

Operations commenced in November 1982 when the first module was offloaded at the Breakwater Wharf in New Plymouth. The final backhaul did not occur until April 1984. Haul times for the 26 km journey varied depending on trailer type, the larger loads however made the journey in an average of 6-8 hours. Although roads remained open ahead and behind the transporters, diversions were necessary to get around the heavily loaded trucks and trailers.

Typically each journey required two pilots, two supervisors, three drivers and a trailer operator. The exact amount depended on load size and associated council or Ministry of Transport regulations. Further labour requirements included the presence of council staff, Ministry of Transport and Police personnel to control traffic and the onlookers.

What was perhaps most remarkable was the extent of public interest in the haul. Newspapers and radio ran announcements of route times and crowds would appear along the route to watch and observe progress (see photo 3). On some days up to 20,000 people lined the streets of New Plymouth to watch the larger assemblies roll by. One wonders how officialdom nowadays would handle the public interest.

Summary

Despite over 25 years having passed since this operation, the amount of preparation needed provides a useful reminder that large scale infrastructure projects require vast amounts of planning on all fronts. The transportation of extremely large and/or heavy components constitutes a major logistical and engineering operation in itself.

About the Author

Bernard Hill is a professional Civil Engineer who graduated with Honours from Canterbury University. Bernard has over 30 years' experience in managing complex and demanding civil engineering and building projects in NZ and overseas. Apart from his leading role in the Motunui project, the list of the projects in which he has had commanding participation is long and covers an impressive range of important industrial and commercial infrastructure realisations. He is currently Project Director with Hawkins Infrastructure.

Enhancing SME Productivity in the Infrastructure Construction Sector

With the support of InfraTrain New Zealand, CAENZ has launched a new initiative: research on the productivity of SMEs in the construction sector. The work will be led by Neil Allan (who also led the Study of the Cyclical Performance of the New Zealand Construction Industry - see CNZ 10). A recent Treasury report highlighted the need to improve New Zealand's low productivity. Construction accounts for 10% of GDP, yet, in common with many countries, the growth in construction productivity lags behind the general economy and other industrial sectors (see Figure 1.)

Figure 1: Comparative Productivity Indices: USA

It has been argued that much of this can be put down to lack of capital investment and innovation, but labour productivity still remains a stubborn and misunderstood factor, particularly in New Zealand. Ever since the Second World War various incentive schemes and time-related studies worldwide have been conducted to tease out more output from construction workers. These were described by the renowned organisational guru Herzberg as mere 'kicks in the ass' in the productivity improvement process.

Couple this with the fact that most productivity studies have been carried out among large enterprises... while there has been little attention of what happens among small and medium enterprises, while New Zealand, like most advanced economies, relies on SMEs as the main engine of growth. The need for specific productivity studies within the SME range is highlighted by research in the European Union which clearly demonstrates that the smaller the enterprise, the lower the added value or productivity (see Figure 2.)

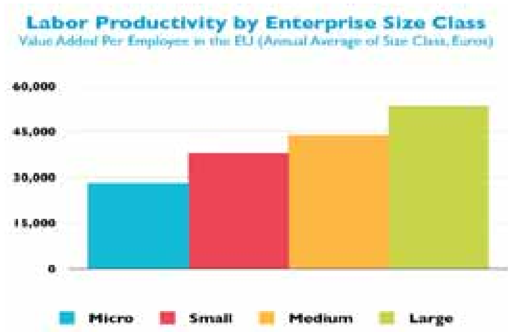
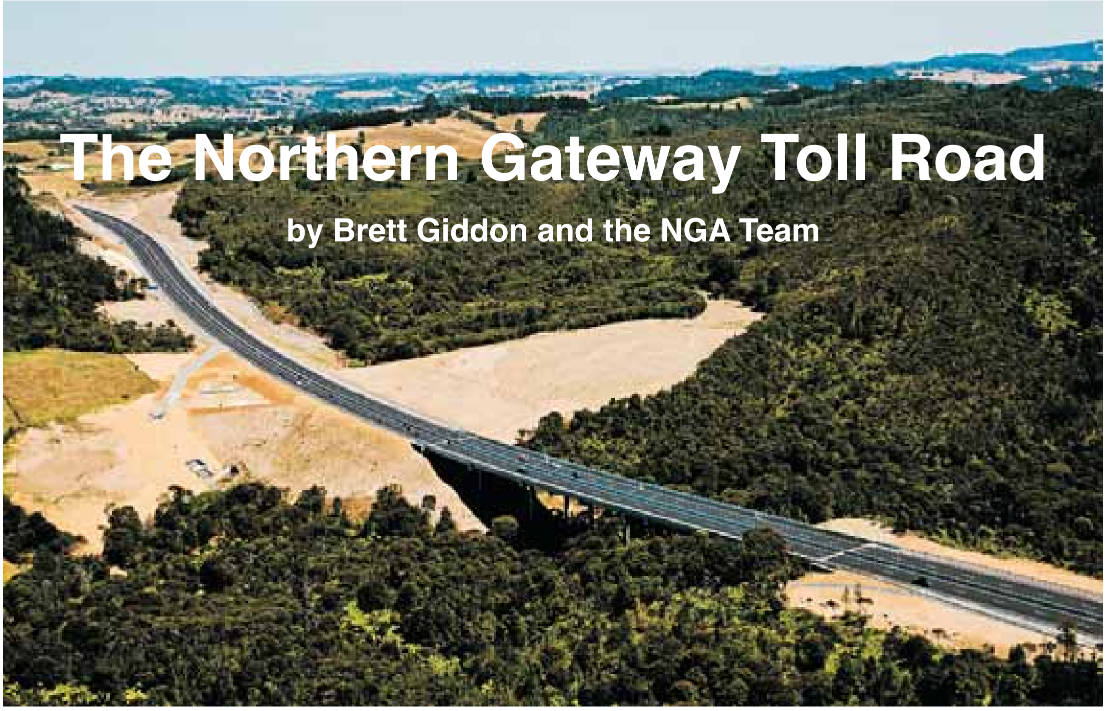


Figure 2: Labour Productivity in the European Union

Given this background, CAENZ realises the importance of studying construction SMEs in New Zealand and contributing to the identification of the causes of lower productivity, and the means to improve it. However, it is a major task, and CAENZ is looking for volunteers to help in the research – and small and medium enterprises to open their doors to the research, seeking the improvement of their on lot and that of the industry and the economy as a whole.

If you are willing to help, or have a case worth studying, please contact Scott Caldwell at 03 364 2478 or email: s.caldwell@cae.canterbury.ac.nz for more details.



The Northern Gateway Toll Road

by Brett Giddon and the NGA Team

The New Zealand Transport Agency (NZTA) engaged the Northern Gateway Alliance (NGA) in March 2004 to design and construct the Northern Gateway Toll Road, an extension of the northern motorway between Orewa and Puhoi. The 7.5 km route improves access and provides a safer, more direct journey for travellers between Auckland and Northland.

At a total cost of $360 million and four years in the making, the project involves twin tunnels, six major bridges, five major new culverts, 4 million cubic metres of earthworks, 60,000 cubic metres of concrete, and at its peak, 300 staff. The road opened ahead of schedule on 25 January 2009.

The toll road passes through a historically rich and diverse landscape containing steep topography, large tracts of native bush, regionally significant streams and estuaries, and areas of pastoral farmland, making it one of New Zealand's largest and most challenging roading projects. The NGA embraced the opportunities presented within this complex setting out to realise its vision of creating a Northern Gateway that is a visual showcase of environmental and engineering excellence.

Six Alliance partners and two sub-Alliance partners made up the Alliance and each member played a critical role in ensuring the project was innovative, efficient, and cost-effective. The NGTR was the NZTA's largest capital project. It was also the first State Highway to be progressed as a toll road, the first construction project to report against triple bottom line measures, and the first roading project in New Zealand to actively work on reducing its carbon footprint.

The NGA incorporated social and cultural considerations on the project from a very early stage, including avoiding adverse effects on the environment, ensuring the views of affected communities were taken into account, and considering various design options. The project delivered excellent outcomes as a result of this open, proactive approach. One of the keys to its success was the Alliance model, which inherently involves integrated decision making and facilitates innovative thinking. The NGA raised the bar for engineering and environmental excellence, setting a benchmark for future alliancing projects.

Complexity

The complexity of the project was key to the selection of the 'Alliance' delivery method and allowed for integrated decision-making involving client, designers and constructors making "best for project" decisions. The issues that added to the complexity included:

- The Land Transport Management Act - the NGTR was one of the first projects to be constructed under the new legislation.
- Requirement to deliver a fully operational tollway under the LTMA, at the optimum whole-of-life cost.
- Scope uncertainty and the need for design refinement.
- Consent conditions and the need for refinement to enable construction.
- Geotechnical risk.
- Sensitivity of the environment.
- Aspiration to achieve value for money.
- The need to expedite the programme to comply with the Environment Court decision regarding the use of Grand Drive in Orewa.

The NGTR was the last stage of the motorway link from Albany to Puhoi and the Alliance delivery method was best for all parties to share and manage the risks and opportunities inherent in this difficult and challenging project.

Innovation

The project provided the NGA with considerable scope to innovate. Some key novel features of the project are highlighted below.

Fish passage and habitat

Resource consent conditions issued for this project required fish passage to be provided for perennial streams crossed by the motorway alignment. A further condition stipulated that passage had to be available for 90% of the time during the whitebait migration period between September and February. Based on habitat surveys, culverts needed to become fish passes fit for the weakest swimming of the fish species present.

Previous solutions for fish passage on other motorway projects had made use of wooden blocks glued to culvert floors, but these had proved to be unreliable. An innovative solution was developed by the NGA team, which provided fish passage by the installation of specifically designed plastic baffles at 10 m intervals along the culverts. These baffles create the right hydraulic conditions for NZ native fish to swim through the culverts with ease.

Once installed the functionality of the baffles was tested and verified by NGA ecologists and specialists working for the Department of Conservation, (DoC). Results showed all species were able to swim unimpeded through the culverts.

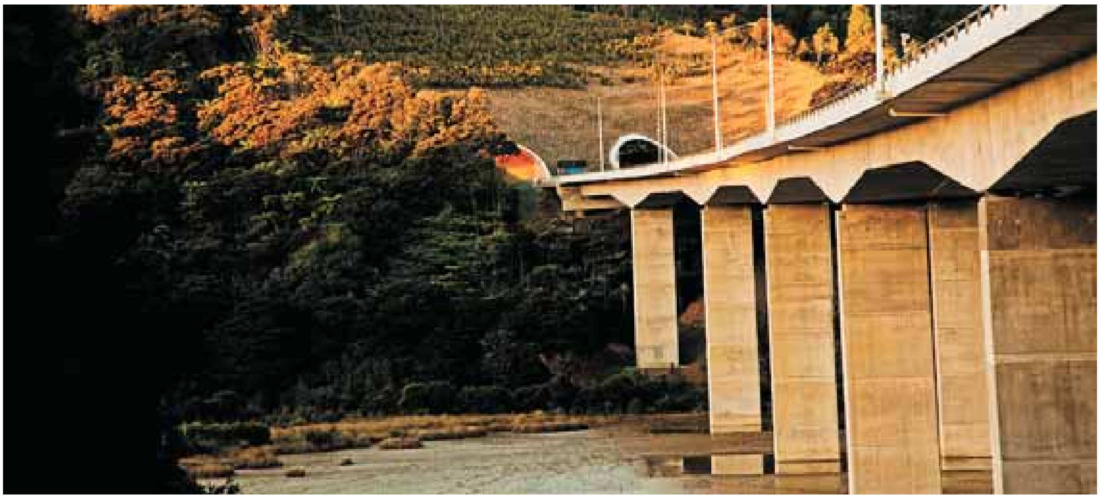
A further improvement made by the team was to create fish habitat by using rocks within the baffles to mimic a natural stream with a series of pools and ripples. The success of this initiative has been verified by an on site assessment with the Department of Conservation.

Deep lift asphalt pavement

Following a review of the pavement design proposed when preparing the Target Outturn Cost (TOC) for the project, the NGA agreed to change from a granular pavement to deep lift structural asphalt pavement.

This decision provided a step change that had been previously thought untenable. The Alliance resolved that, despite an additional cost for providing a deep lift asphalt pavement, the reduction in risk and significantly better whole-of-life cost due to less maintenance, made it the 'best for project' decision. Furthermore, the Alliance chose not to align itself with the status quo of using one pavement across the full width, instead, constructing the deep lift asphalt in the traffic lanes only with unbound granular pavement shoulders sealed with chipseal. This decision provided significant savings from the conventional method.

With the change from an unbound granular pavement to a deep lift asphalt pavement, the



NGA identified an opportunity to achieve an extremely smooth finished surface. The NGA achieved an average NAASRA (National Association of Australian State Roading Authorities) count of 27, with sections between the bridges as low as 23 (the industry norm is a range of 35 to 55). This low score is exceptional with the benefit to the end user being a smooth ride and reduced vehicle wear and tear.

Elegance of solution

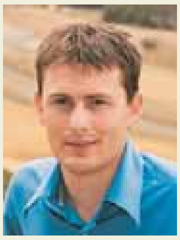
When you drive along the NGTR you start to appreciate the enormity of the task of building a motorway standard road through such terrain. You can also understand why this complex project was delayed for many years. The NGA has managed to achieve an alignment that winds its way effortlessly across the valleys and through deep cuts. The road is a seamless ribbon of asphalt amongst regenerating native bush. The detail has been kept simple to allow the environment to shine. Given time the native trees will come to within a metre of the carriageway enhancing the project even further.

The conventional geotechnical approach to large cuts in landforms is to create three to five metre wide benches, which simplifies issues associated with stormwater runoff and erosion maintenance, etc. It does, however, create a very 'engineered' landscape with a saw tooth profile in the hillside and little opportunity to integrate cut slopes into the wider landscape. The NGA decided not to bench the cuts and adopted an approach that would enable a high level of landscape integration. The result is quite evident when you drive along the route. In 2007 NGA won two NZILA awards (design and sustainability) and the judges citation mentioned the high level of landscape integration on the project.

Generally, cut slopes were steepened from 1:3 to 1:1 slopes in rock and 1:2 in soils. These measurements substantially reduced the motorway footprint. Likewise, the fill embankments were steepened from 1:3 side slopes to 1:2. With several fill embankments along the project between 20 m and 35 m high, this design enhancement reduced the encroachment into environmentally sensitive streams by between 20 m and 35 m on both sides of the embankment. Furthermore, innovative drainage design reduced the top formation width by 3 m on each side by deleting the conventional catchpit and manhole system. These were replaced with flow through grated manhole type catchpits and pipelines under the kerb and barrier. This measure further reduced the footprint of the road, reduced earthworks volumes and drainage materials, and contributed to four hectares of native bush being saved from clearance across the project.

The step change from the specimen design to the final product has exceeded both the NZTA and stakeholder expectations and raised the bar for future projects. The NGTR is a legacy for future generations that the NZTA, the NGA, and all road users can take pride in.

About the Author



Brett Gliddon has been with the New Zealand Transport Agency (previously known as Transit New Zealand) for the past nine years. In this time he has work in the Highway and Network Operations Division delivering a number of large scale roading and public transport infrastructure projects. For the last three years Brett was the Client Representative and Engineering and Compliance Manager on the $360m Northern Gateway Toll Road project. Brett has recently been appointed Principal Project Manager for the Puhoi to Wellsford Corridor upgrade project, the planning and development of a further 38 km of 4-lane state highway north of Auckland.

Editor's Note

The Northern Gateway Toll Road is, indeed, a remarkable engineering project, initiated by Transit New Zealand, and opened in 2009, shortly after TNZ was incorporated into the NZ Transport Agency. The road is, indeed, a credit to the engineers and managers who executed the 2004 instruction to design and construct a motorway capable of carrying the Auckland holiday traffic safely towards its northern destinations – safely and in comfort. It sweeps gently through and above the broken topography of some of its alignment, with easy gradients and gentle bends, tunnelling where the depth of cut would have divided the habitat of local native species. Likewise, its magnificent bridges fly over lush native bush and the habitats of local fauna.

However, when I visited the construction site, back in 2007, I was perplexed: was this a motorway in New Zealand or somewhere in North America or Europe? I was left wondering whether NZ could afford the luxury of those sweeping curves, gentle gradients, massive excavation, huge bridges, all for just 7.5 km of road. Toll charges will not pay for the $360 million cost: they will cover the cost of the toll collection system, and little else. And this is simply because the economic justification of the development was based on sporadic traffic counts: holiday and weekend traffic from Auckland to the leisure areas of the North.

NZ has urgent needs elsewhere, and I cannot but think that $360 million could have contributed to the improvement of critical problem areas in the State Highway system; or the obsolescent railways, the weakening inter-island power link, the shortage of generating capacity, or many other pressing infrastructure issues that NZ faces today. For a measure of scale comparison, consider this: our land area is greater than that of the UK, and our population is about one-tenth that of Britain – and we cannot sustain the traffic counts that justify European-style motorway networks, nor afford investing our much smaller taxation and resource base on assets that do not have a more tangible and immediate effect on our economy. Much as I admire the engineering and elegance of the Northern Gateway motorway, I still wonder if it was the best decision for the nation. EH

(continued from page 2)

The 'EnZed' Brand

Constructing New Zealand is not only about bricks & mortar and bridges & power stations. It is also about making our Trade Mark well known and appreciated in the world at large… and I have found that the efforts applied to this end are producing excellent results in Europe – including, of all places, in Spain.

As an anecdote, many years ago, while visiting Spain, I wanted to send a postcard to my parents in Lima, Peru. In my native Spanish, I asked the post office clerk for airmail stamps for Peru. "Beirut? That's in Lebanon, right?" … "No! P - E - R - U", I responded. "Where is that?" she answered, to my astonishment. This, from a postal clerk in a country that had been made rich and became the most powerful European empire of the 16th to 18th centuries, thanks to Peruvian (and Mexican) gold.

Scroll forward to 2009. We were recently touring Spain and came across an equally astonishing amount of knowledge about, and personal experiences on New Zealand: from a taxi driver in Madrid, who had come as a tourist and driven from Cape Reinga to Bluff; from a hotel maid in Ampurias, whose daughter and husband had spent a year here and lamented they could not stay longer for lack of the appropriate residence permit; and on the label of a soft drink, which we enjoyed in the Alpujarras (a remote area of the Sierra Nevada) which offered a trip to New Zealand, all expenses paid, to the winner of a competition sponsored by the well-known, national bottling firm.

And everywhere, there was instant recognition of New Zealand – we were never asked "where is that?" Nor did we have to spell Nueva Zelanda. Not once.

Is it just because New Zealand happens to be the Spanish antipodes, thus exciting the curiosity of adventurous Spaniards? I don't believe that. Rather, a bouquet is due to those who have been spreading the word about New Zealand. The lesson in productive, well-aimed publicity dollars is also worthy of note: for the relatively small cost of a trip for two, the New Zealand brand has reached the most recondite corners of a European country. Has this been replicated elsewhere? Is there more in the pipeline?

Food for Thought

A couple of articles in *The Economist*, 1st. August 2009, have made me think. I just place the ideas here for someone to develop, or otherwise to have a tantrum over:

"Room service not included" is one heading… and refers to a proposal in the USA to charge those convicts who can afford it, for the room and board during their "stay".

"Keeping it local" is another article, also drawn from the USA: the multiplying effect of buying from local firms, as opposed to shopping in chain stores come from elsewhere, is a current subject of discussion. Some economists have found that local businesses put twice as much money back in the community they serve.

Interested? You know the source of the thoughts… write to us if they touch a bee in your bonnet…

Ernesto Henriod

Contact Information

ConstructingNZ is published by the New Zealand Centre for Advanced Engineering.

Mail: CAENZ, University of Canterbury Campus, Private Bag 4800, Christchurch 8140

Phone/Fax: (03) 364 2478 / (03) 364 2069

e-mail: constructingnz@caenz.com

web: www.caenz.com

Submissions & Comment

We are pleased with the growing readership of our Newsletter and the comments we receive. Please keep in touch with us, let us know what subjects you would like us to pursue, do use our pages as an opportunity to open up or participate in debate on construction industry issues.

The deadline for material for the next issue of CNZ is 30 November 2009.

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