PROJECT ALLIANCING AND INNOVATION

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ABSTRACT

This paper discusses how innovation can be a key factor in the successful delivery of large-scale infrastructure projects undertaken in Australia. The framework of an Alliance is introduced as a project delivery mechanism for promoting innovative design and construction techniques. Two current road infrastructure projects within the Sydney region are used as illustrative case studies of Alliance projects - the construction of Lawrence Hargrave Drive and the Windsor Road Upgrade. Finally the Authors provide a summary of their experiences and lessons learnt as Geotechnical Engineers while actively participating in the abovementioned projects.

1. INTRODUCTION

Traditionally large civil engineering projects are undertaken using design and construct contractual arrangements. For most situations, this has generally proven to be an effective delivery mechanism for projects with readily definable deliverables and risks for both client and constructor. However, in circumstances where risks are unpredictable, there are rigid timeframes and the scope of works cannot be clearly defined, key stakeholders are looking for alternative contract delivery mechanisms.

One such alternative originating from the oil and gas industry and developed within the past 30 years, but only recently utilised for major Australian civil infrastructure projects, is the concept of Alliancing or "relationship contracting". The key idea and subsequent success of Alliance contracting is based upon achieving extraordinary outcomes or "breakthrough performance" as a result of innovation.

This paper discusses the principles of Alliancing. To further illustrate innovation as the major factor underpinning the success of Alliancing, two Alliance projects currently being undertaken in New South Wales, are presented.

2. ALLIANCING

There are numerous definitions offered by industry experts relating to Alliancing. One such definition provided by Ross (2003) is as follows:

"a project alliance is where an owner (or owners) and one or more service providers (designer, constructor, supplier, etc.) work as an integrated team to deliver a specific project under a contractual framework where their commercial interests are aligned with actual project outcomes."

This explanation can be simply summarised as, *all stakeholders form a team that either wins together or loses together*.

Projects delivered under an Alliance contract, typically comprise one or more of the following characteristics:

- Unpredictable or undefinable risks;
- Rigid or tight timeframes;
- Complex or undefinable scope; and
- Political or public pressures.

Furthermore, Ross (2003) suggests that stakeholders choose to deliver projects by Alliancing as project outcomes are more likely to be achieved (or exceeded) if all the key participants, owner and contractors, assume collective responsibility for delivering the project. That is, by forming a *Project Alliance*.

Key features of a project Alliance include:

- Alignment of objectives amongst all Alliance participants;
- Collective responsibility for all project deliverables;
- Performance based risk/reward system measured against defined Key Performance Indicators (KPI's) to determine the gain-share/pain-share of the Alliance participants;
- A no blame culture;
- No adversarial relationships;
- "Best for Project" decisions;
- Open and honest communications between all Alliance participants; and
- The concept that no idea is a dumb idea.

In Project Alliancing, the owner seeks to drive outstanding performance or "extraordinary outcomes" by making all of the Alliance participants collectively responsible for the overall success of the project, both in its fitness for purpose and total cost of completion. This is generally achieved by providing commercial incentives to the Alliance participants by way of bonuses for early completion or delivery at reduced project outturn cost. These incentives are introduced to generate an Alliance culture that looks to solve complex problems with innovative solutions. Similarly, incentives are balanced against disincentives whereby poor performance is not rewarded. The organisation chart for a typical Alliance contract is given in Figure 1 below.

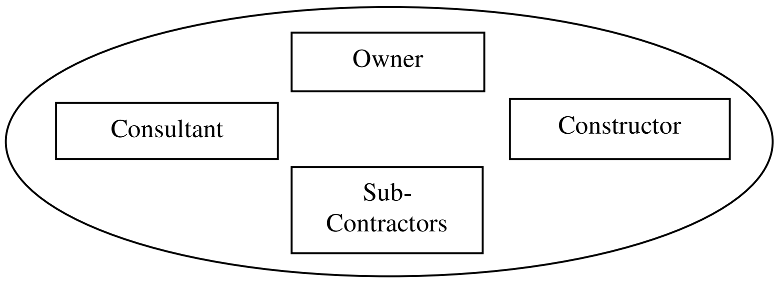

Figure 1: Alliance Organisational Chart

The two Alliance projects described in this paper each have aspects that satisfy some or all of the above criteria.

3. LAWRENCE HARGRAVE DRIVE

3.1 BACKGROUND

Lawrence Hargrave Drive (LHD) is a 1.6 kilometre section of road north of Wollongong connecting the communities of Clifton and Coalcliff. The road has had a long history of rockfall, debris flow and landslip events since being initially constructed in 1880 until its closure in August 2003 (Refer to Figure 2).

Figure 2: Lawrence Hargrave Drive, View Looking North, February 2004

During this period the road was periodically closed to allow the removal of rock fall and debris flow material that blocked traffic flow along the road (Refer to Figures 3 and 4) or to repair road embankment failures rendering the road surface un-trafficable (Refer to Figure 5).

Figure 3: Rockfall in Southern Amphitheatre, 1949

Figure 4: Debris Flow, 1950

Figure 5: Embankment Failure on Southern Approach, 1988

In 1949 the first major geological study of the area was commissioned by the Department of Main Roads and was completed by L. Lawry Waterhouse in 1952. In 1967 the road was closed for a number of months due to increased rock fall and debris flow activity and in 1988 the road was closed for a full 6 months while damage caused by record rains was repaired.

Since total closure, the Roads and Traffic Authority (RTA) of New South Wales have entered into an Alliance agreement between the RTA, Barclay Mowlem, Maunsell Australia and Coffey Geosciences called the *Lawrence Hargrave Drive Link Alliance*. The Alliance was charged with developing an Engineering solution to reduce the risk to road users to "acceptable" levels, while taking into account the impact to both the community and the environment, and the limited timeframe set to complete the works.

The large range of potential engineering solutions to achieve the project objectives, the community (stakeholder) issues and the tight timeframe allowed to deliver the works were some of the factors that led the LHD project to be established as an Alliance.

3.2 ALLIANCE EXPERIENCES

3.2.1 Development of the "Preferred" Solution

Following the formation of the LHD Link Alliance, the task of developing Engineering solutions commenced. This process was driven by the Alliance Management Team (AMT) with technical input from the Wider Project Team of the Alliance. At the conclusion of the selection process, the "preferred" development option consisted of the construction of two bridges to span the southern and central legs of the road and the geotechnical stabilisation of the northern leg utilising the existing road alignment.

3.2.2 Relationship Innovation

During the design phase of the LHD project, the design teams were co-located in an Alliance office. The stages of the Author's involvement during this phase of the LHD project consisted of major site investigations (stage 1), the development of a geotechnical model (stage 2) and bridge pile foundation analysis (stage 3). The first two stages were critical to the success of the subsequent design stage and required the collective effort of the Alliance Geotechnical Design Team to achieve the necessary outcomes. The bridge pile foundation analysis stage required a high level of interaction between the Geotechnical and Structural Design Teams.

The Alliance design team members were selected on a "best for project" basis with each of the team members demonstrating a high level of motivation and commitment to the Alliance. This readiness to embrace an Alliance culture meant that rapid feedback and close interaction between members of the team was the norm.

The major innovation that was achieved during the design phase was harnessing the commitment to teamwork of the Alliance participants. The geotechnical and structural design teams developed innovative systems and processes for the streamlined production of the design deliverables. Coupled with the benefit of using sophisticated methods of analysis, these systems and processes allowed the design deliverables to be created efficiently, accurately and with a minimum of rework.

This is one example of what the Author terms *Relationship Innovation*. Varying levels of Relationship Innovation may be achieved during a particular design phase based on the level of commitment of the stakeholders and Alliance team to communicate and understand each of the other parties' specific needs.

It is the Author's belief that a *high level* of Relationship Innovation was experienced during the pile foundation design and was repeated on numerous occasions during the course of the design phase with a commensurate increase in the efficiency of the production of design deliverables.

3.2.3 Difficult Access Site Investigation

At the time of conducting the major site investigations, a number of the investigation locations were not accessible using standard drilling rigs and equipment. As an alternative to building access tracks and delaying the collection of geotechnical data, difficult access rigs that could be dismantled and carried by hand and reassembled at the investigation location was commisioned. This rig in operation is shown below in Figure 6.

Figure 6: Difficult Access Rig On-Site

3.2.4 Rockfall Model Calibration

Whilst conducting the site investigation the Author witnessed a rockfall in the Southern Amphitheatre at the site. The Author recorded the estimated initiation point of the event, measured the size of fallen boulders and their respective impact locations. This information was given to the geotechnical team responsible for simulating rockfalls at the site using computer software.

The innovation achieved consisted of the collection of critical data at the time of the occurrence and the production of an event report that allowed the geotechnical team to calibrate the computer models and produce more accurate rockfall simulations. These simulations were undertaken to assess the potential impact locations of boulders with varying initiation points and block sizes.

3.2.5 Piled Foundations Analyses – Torsion Loading

The construction method used to form the southern bridge section produced a complex loading system on the pile groups. No analysis package was available to analyse this complex loading system. Two sophisticated analysis packages were used together to conduct the analyses. The first program modelled layered soil profiles but was unable to analyse torsion loading. The second package was able to analyse full 3D loading of a pile group, including torsion loading, but modelled the soil profile beneath the surface as a linearly increasing function of shear modulus.

These two programs were calibrated against one another and used to determine the dominant effect of torsion loading. It was assessed that torsion loading amplifies the bending moments induced in piles.

The innovation in this instance consisted of the development of a system to apply two analysis packages to assess the effect of torsion loading on pile groups and produce amplified moment diagrams for use by the structural design team.

3.2.6 Progress of Bridge Construction

The construction of the LHD bridges is well underway with progress photos at the time of writing this paper shown in Figures 7 and 8.

Figure 7 – Incrementally Launched Bridge

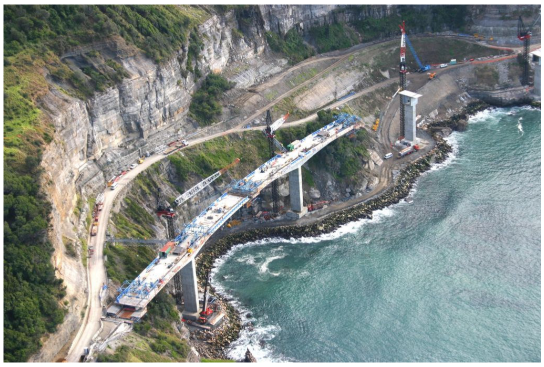

Figure 8 – Balanced Cantilever Bridge

3.2.7 Lessons Learnt

As a Geotechnical Engineer working in a Project Alliance environment, the Author witnessed and experienced the benefits of a high level of commitment to teamwork of Alliance participants, referred to herein as Relationship Innovation. An increase in both the quality of the design deliverables and the speed with which they were produced was the result.

The Authors acknowledge that one of the primary reasons for establishing a Project Alliance is to harness the potential Relationship Innovation that may develop within an Alliance design team, and this characteristic is the result of working within an Alliance environment. The degree to which this is achieved during any particular Project Alliance is an intangible quantity that is highly dependent upon the commitment of the individual Alliance participants.

Other Innovations achieved on the LHD project demonstrated to the Author that the pursuit of alternative solution methods, whether to a practical challenge in the field or in complex computer analyses, allowed the Alliance to exceed "business as usual" practices.

4. WINDSOR ROAD UPGRADE

4.1 BACKGROUND

In December 2004, RTA, Leighton Contractors, Maunsell and Coffey Geosciences formed the Northwest Connect Alliance responsible for the design and construction of the upgrading of Windsor Road between Baulkham Hills and Kellyville. The upgrading works comprise the widening of approximately 5.5km of a predominantly single carriageway road to a dual carriageway. The site is divided into two separate sections referred to as the southern and northern sections. The southern section is approximately 3km long and the northern section is 2.5km long and passes through a combination of residential, commercial and semi-rural areas. This section of Windsor Road is one of the oldest and currently provides a congested artery for about 40,000 vehicles per day.

The upgrade of this section of road was selected by the RTA to be undertaken as an Alliance because of the high risks associated with the project, some of which include:

- Completing the project within a short time frame;
- Constructing a road within a tight corridor;
- Obtaining land acquisitions;
- Relocating the multitude of existing services;
- Construction of numerous proposed services;
- Constructing the road widening whilst maintaining current traffic flows;
- Managing community expectations;
- Preservation of known archaeological finds and areas of historical significance;
- Constructing a road with a high level of urban design features; and
- Managing environmentally sensitive areas adjacent to Windsor Road.

By adopting an Alliance structure, the project team has been able to operate within a team environment where risk has been more readily accepted and managed accordingly by all Alliance participants. If the project was conducted under a more traditional design and construct mechanism, the high level of risk associated with the project would most likely have attracted a significant level of contingency built into the project timing and cost, to account for the high level of uncertainty.

As outlined in section 3, a commercial incentives or a "bonus pool" system was adopted to drive outstanding performance within the Alliance. The performance of the Northwest Connect Alliance will be judged on the following Key Result Areas (KRA's):

- Cost;
- Time;
- Quality;
- Environment;
- Safety;
- Community; and
- Urban design.

The assessment of the success of the Windsor Road Upgrade by means other than cost and time alone is typical of Alliance projects. The process ensures the likes of quality, the environment, safety, community expectations and urban design, which are non-cost drivers, are not sacrificed at the expense of cost and time.

4.2 ALLIANCE EXPERIENCES

From the onset of the Northwest Connect Alliance, there has been a focus on innovation in design to facilitate the development of outstanding outcomes for the client and for the community. Innovation registers have been used by the design and construction teams and this is one example that highlights the drive for innovative solutions on the project.

4.2.1 Geotechnical Retaining Wall Design

Design of the retaining walls lead to innovations in other areas of the overall project because designs were not considered in isolation. The Alliance structure provided an environment where a holistic view of the retaining walls could be considered. Close interaction between the geotechnical, structural, construction, drainage engineers, traffic engineers and urban designers allowed for each wall to be assessed independently and as part of the overall project. This produced innovations that were not always obvious upon first glance. In some cases, the consultation process resulted in the adjustment of the road cross-falls and the road alignment to reduce wall heights and in some cases eliminate a number of walls – resulting in significant cost savings. Reducing wall heights or eliminating retaining walls also had a knock-on affect of reducing the impact on other construction elements such as underground services, landscaping and ongoing land acquisitions.

4.2.2 Pavement Thickness Design

The pavements on the Windsor Road Upgrade form a significant construction cost because of the variable ground conditions and therefore the "business-as-usual approach" was challenged in an attempt to optimise the pavement thickness design. This comprised additional geotechnical testing to better understand the behaviour of the pavement subgrade materials. Key parameters of pavement design include California Bearing Ratio (CBR) and swell of the subgrade material. The CBR gives an empirical indication of material strength and the swell gives an indication of the reactivity of the material. In terms of pavement design, the higher the CBR value the thinner the overall pavement. A subgrade with a low swell value generally removes the design requirement for a capping layer or in situ stabilisation of the subgrade.

In accordance with typical design guidelines for NSW, pavements are designed for CBR values obtained on subgrade samples compacted to 95% standard maximum dry density under a 4.5kg surcharge. The 4.5kg surcharge conservatively models an equivalent pavement thickness of about 250mm. Considering the pavement thickness for the Windsor Road Upgrade typically varies from 700mm to 950mm, it was decided to investigate the effect of increasing the CBR surcharge to 9kg and 13kg to more closely model the proposed pavement thickness. In addition to increasing the CBR surcharge load, the affect of carrying out CBR tests on samples compacted to 98% standard maximum dry density under 4.5kg, 9kg and 13kg surcharges was investigated.

The limited test results indicated that under a higher surcharge loading and at a higher compaction level, CBR values did increase and swell values did decrease, although due to variability of the materials tested, there were some outlying results. For reasons that cannot be discussed here, this innovation was not followed through. However, it illustrates a classic example of adopting existing technology and applying it in different way to challenge the business-as-usual approach to pavement thickness design.

4.2.3 Lessons Learnt

As a result of working on a Project Alliance, the author was able to identify a number of factors that can contribute to the success of an Alliance which include:

- The importance of obtaining collective input from all Alliance participants when evaluating design options prior to commencement of detailed design. Specific areas can include the road alignment, traffic management, existing and proposed services, constructability, structural design and urban design. Taking advantage of a collaborative Alliance environment minimises the requirement for redesign and rework, saving time and money;
- Established processes used during the design phase can be analysed to determine how appropriate they are to a given situation. The identification of what is actually trying to be achieved is important so that the process is tailored to the given situation to provide appropriate outcomes;
- The importance of communication between project team members with different skill-sets, to improve the knowledge base contributing to the development of solutions.

The Windsor Road Alliance has provided a culture, which encourages such processes and enabled the project team to consider a range of viewpoints before arriving at 'best for project' solutions.

5. CONCLUSIONS

- The authors have shown through their experiences on two projects within the Sydney region that Project Alliancing is an effective project delivery mechanism for delivering large infrastructure projects where tight timeframes, the potential for scope changes and community issues all influence the proposed infrastructure rollout.

- "Relationship Innovation" is the close interaction that can develop between design teams in an Alliance culture, and can be one of the primary outcomes of Project Alliancing. During the LHD Link Alliance design phase a *high level* of Relationship Innovation was consistently experienced between the design teams participating in the Alliance. This consisted of mutual understanding and effective communication between members of the Wider Project Team.

- The major innovations that occurred during the LHD design phase was to harness the *high level* of Relationship Innovation that existed between Alliance participants and challenge "business as usual" practices to produce design deliverables efficiently, accurately and with a minimum of rework, utilising sophisticated analysis methods and technology.

- The Windsor Road Alliance through a 'best for project" assessment of project issues, continues with the design and construction phase in a cost and time efficient manner. The focus on innovative processes as well as technical innovation, has to date provided a means to develop outstanding project solutions for the RTA and the community.

6. ACKNOWLEDGEMENTS

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Photos are reproduced courtesy of the RTA photo records section and the LHD Link Alliance.

7. REFERENCES

Ross, J. (2003). "Introduction to Project Alliancing (on engineering and construction projects) April 2003 Update." *Alliance Contracting Conference, Sydney, 30 April 2003.*