INTRODUCTION

Major structures always present special challenges in commercial matters, logistic, cultural, engineering and technical items.

The “norms” we come to accept in a developed country are not the same in developing countries.

Matters surrounding concrete and construction need extensive experience and consideration, detailed planning and proactive implementation to ensure a successful outcome.

The author and consultants from his company have been involved in many projects in Asia and Eastern Russia over the past 10 years.

Careful consideration of key issues has been crucial to achieving specification and the general outcomes have been successful.

This paper and conference presentation will provide some information and experiences on projects in the Philippines, Russia and Taiwan.

HIGH PERFORMANCE CONCRETE

There are numerous definitions of this and I will not attempt to create another. On the projects this paper addresses, there are key performance criteria of concrete which relate to structure and its need to attain chloride resistance, resist and suffer impact, sustain heavy loads and freezing and thawing and withstand ice abrasion, resist sulphate attack and mitigate AAR.

MALAMPAYA CONCRETE GRAVITY STRUCTURE

This was constructed by the Malampaya Concrete Alliance (John Holland, Arup, Halliburton and Van Oord ACZ) in 1999 – 2000.

Project Facts

The Malampaya Platform is comprised of a three level Topside and the foundation plus four shafts. The foundation and shafts are termed the ‘Concrete Gravity Sub Structure’, or CGS.

The Malampaya development is a landmark deep-water project to supply natural gas to power plants within the Republic of the Philippines from 1 October 2001.

The platform is located in 43 meters of water, with deepwater subsea wells located in 850 metres of water.

The processed gas is compressed and exported through a 504 kilometre pipeline to the Batangas onshore facility at Luzon Island in the Philippines.

The condensate is stabilized on the Topside, stored in the CGS and then exported to a shuttle tanker through a catenary anchored leg mooring (CALM) system located 3 kilometres from the platform.

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1 Managing Director, ANCON Beton
**Concrete Gravity Based Structure**

**Construction Facts**

- Dry dock Excavation volume = 320,000m$^3$
- Base Dimensions = 110m x 81m x 16m Ht
- Number of Shafts = 4
- Shaft Height = 40 metres
- Shaft Diameter = 11 metres
- Concrete Volume = 34,000m$^3$

**Reinforcement Density (Average) 358kg/m$^3$**

- Reinforcing Steel = 8,500 metric tonnes
- Prestress Steel = 610 metric tonnes
- Weight = 74,000 metric tonnes
- Total Storage = 431,000 bbls
- Net Storage = 385,000 bbls
- Solid Ballast Wt, = 36,000 tonnes dry
- Scour Protection = 20,000 tonnes
- Concrete works 11 months

**Project Consultancy**

ANCON assisted with most aspects of concrete, materials and specific aspects of construction.

ANCON was engaged by John Holland and worked in close cooperation with Arup’s London office.

Pilot concrete development was carried out at tender stage and this lead to a smoother and faster development after the project was awarded to the Malampaya Concrete Alliance.

Five ANCON consultants assisted with various aspects of the concrete and construction, both on site and with home desktop support from Australia. Consultancy services included:

- Concrete Materials and Resource Assessment
- Concrete Plant Commission
- Concrete Production Advice
- Durability Assessment
- Mix Design and Development
- General Concrete Technology
- Laboratory Advice
- QA Documentation
- Performance Assessment
**Project Challenges and Actions**

Concrete for Malampaya was one of the project’s major challenges. Limitations existed with local materials, however, the challenge was to produce a consistent concrete that was user friendly, and would achieve strength and attain long term durability.

Research of the local coarse aggregate resulted in a need to source material some considerable distance from site in the province of Bataan. The Robust Rock Quarry was new, with a new state of the art crushing plant and this was selected for supply. ANCON provided site inspection of reserves and crushing plant and installation of QC/QA procedures. Specially selected and screened local river sands were used, however, the sand in all surrounding areas contained Lahar (volcanic pumice from the Mount Pinatubo eruption in June 1991). QC/QA procedures ensured this was kept to an absolute minimum.

A local ASTM C150 Type 1 cement was selected because it was of known quality for high strength concrete and it had a guaranteed 40MPa ASTM C150 strength and consistent setting time.

Local fly ash from Masinolic was used. The concrete contained Pozzolith 300R retarder of varying dosage rates, together with split dosage of Rheobuild 2000 partially added at the batch plant and partially at a slumping station.

The mix design was developed with trials by ANCON in John Holland’s Manila and site laboratories. The mix developed incorporated nearly 30% fly ash and 3 to 4% silica fume. The purpose of this mix combination was to:

- Ensure that the potential reactivity for AAR of the pyroxene andesite crushed stone and lahar in the sand was suppressed by the use of fly ash and silica fume. Expert geological advice and AAR advice was provided by ANCON specialists in this field. ASTM C1260 Accelerated Mortar Bar Testing was carried out with various cementitious combinations and a selection on ingredients for the concrete was based on combinations that gave innocuous results.

- The mix was developed with various dosages of retarder for setting time requirements and these correlations were developed to cater for the various dimensions for the walls and shafts and slip form rates.

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Project Construction Photo 2

Two computer operated John Holland batch plants with overhead bins were set up on site. Full ISO9000 QA procedures for the batch plants and QC laboratory were established by John Holland in conjunction with ANCON. The laboratory carried out all routine QC testing of materials and concrete.

Initial slump was 20 - 40 mm prior to addition of Rheobuild 200 superplasticiser. Setting time as controlled by varying dosages of Pozzolity 300R, which also resulted in controlled slump reversion.

Slumping procedures were strictly controlled to achieve slump to order 200 – 220 mm by the addition of the final dosage of superplasticiser at the slump stand located separately from the batch plant.
Concrete performance and project outcome

Grade 50MPa (cylinder) concrete was supplied and attained an average strength of 60.8MPa at 56 days and a standard deviation of 3.4MPa.

The Standard Deviation achieved of 3.4MPa is considered very good by ACI 214 Standards. Specimens were taken for drying shrinkage tests and sent to Australia for measurement. Results were less than 700 microstrains at 56 days. Core samples were also sent to Australia from the base pours and tested for Rapid Chloride Permeability to ASTM C1202. Results were well below 1000 coulombs ensuring a very low rating for Chloride Ion Penetrability.

Rock shrinkage testing was carried out in Melbourne and figures of order 0.018% were attained – resulting in a controlled shrinkage concrete. The concrete had a water/cementitous ration of 0.39.

All concrete used provided excellent performance and in particular an excellent slip form finish was obtained requiring extremely little patching and remediation. The development and actual concrete QA/QC was achieved through extensive communication and coordination between site and also both Arup London office and ANCON’s Adelaide office.

The construction finished approximately 3 months ahead of the program, and was result of the dynamic and proactive management team of the Malampaya Concrete Alliance and its work force.
TAIWAN HIGH SPEED RAIL (THSR) – T200 PACKAGE

Train speed is 350km/hr Photo 4

Transportation capacity Diagram 2

Project Geography Diagram 3
PROJECT OVERVIEW

- BOT project
- Overall project Value US$15B
- Total length 345km double track
- 73% Viaduct, 18% Tunnel and 9% at grade
- Design speed 350kph
- Double track mainline standard gauge at 4.5m centres

Track Statistics Table 1

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<th>Mainline</th>
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Contracts Table 2

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<th>Contractor</th>
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<td>1K+000~16K+800</td>
<td>Taiwan Track Partners Joint Venture (TTPJV)</td>
<td>28/6/02</td>
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<tr>
<td>T210</td>
<td>16K+800~190K+760</td>
<td>Taiwan Shinkansen Trackwork JV</td>
<td>30/12/02</td>
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<tr>
<td>T240</td>
<td>275K+000~346K+374</td>
<td>Taiwan Shinkansen Trackwork JV</td>
<td>18/06/02</td>
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</table>

T200 PACKAGE - TTPJV

- TTPJV – BMCL 42%, Leightons 28%, Heitkamp 13%, Futsu 9%, Hsin Lung 8%
- 32km of track, mostly in tunnel (28.5 km) under Taipei.
- Commenced 28 June 2002, completion due 31 December 2004
- Track forms – LVT (26.5Km), Rheda 2000(3.5Km), Embedded (2Km)
- 24 Turnouts – High Speed, Swing nose, TMS

Project Consultancy

ANCON provided extensive consultancy on concrete and construction.

At the time of writing this paper, it was not possible, at short notice, to gain permission to present some of those details. However, the author will present details at the NZ Concrete Society Conference in September 2004.
SAKHALIN II PHASE 2 – FAR EAST RUSSIA

In December 2003 ANCON received a request from Aker Kvaerner, in Norway, to assist with concrete technology and concrete production on site for the construction of two “Concrete Gravity Based Structures” at the Port of Vostochny near Vladivostok) in Far East Russia.

Aker Kvaerner (from Norway)
For those of you who are not familiar with Aker Kvaerner I have obtained some slides (no 1 & 2) from Aker Kvaerner which will enlighten you on their expertise and past record.

Aker Kvaerner Record Slide 1

International Projects
- Harding (UK)
- Hibernia (Canada)
- West Tuna / Bream B (Aus.)
- Wandoo (Australia)
Sakhalin CGBS in Vostochny

Where is it?

It's 4 hours from Vladivostok. Vladivostok (Far East Russia) is 9 hours by plane from Moscow and if a direct flight was available, about 7.5 hours from Darwin.

Project Location and Contributions Slide 3

The Client and Project

Sakhalin Energy Investment Company Ltd. (SEIC)

- Special purpose company for development of the Sakhalin II Project
- SEIC Project Head Office located at Sakhalin Island
- Phase II consist of:
  - Two Offshore Platforms - PA-B and LUN-A
  - Onshore processing facilities
  - Offshore and onshore pipelines for Gas & Oil
  - LNG Plant
  - Oil export terminal
  - Infrastructure upgrade on Sakhalin Island
**Operator:**
- Sakhalin Energy Investment Company Ltd. (SEIC)
- Shareholders: Shell (55%), Mitsui (25%) and Mitsubishi (20%)

**Offshore field location:**
- East of Sakhalin Island: Piltun-Astokhskoye (PA-B) & Lunskoye (LUN-A)

**CGBS Contracts:**
- H-00290 Engineering and service work
  - Project Management and Engineering: Aker Kvaerner Technology AS - Oslo, Norway
- H-00384 Construction and installation work
  - Construction of Casting Basin and CGBS’s: Quattrogemini OY - Espoo, Finland

**Subcontractors:**
- RROffshore Oy - Ulvila, Finland: Main Mechanical Outfitting
- Aker Marine Contractors AS - Oslo, Norway: Marine Operation
- Finish Engineering and Russian Design Institutes:
  - Engineering
  - Russian contractors and suppliers: Materials, services and construction

**Project Plan:**
- Casting Basin start construction: May 2003
- CGBS start construction: February 2004
- CGBS’s tow out to Offshore Location: June 2005

**CGBS Construction Site:**
Vostochny Port, Nakhodka Fareast Russia

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**The Structures**

**PA-B Concrete Gravity Base Structure Slide 5**

**Key Facts**
- Topside weight: ~33,000 t
- Water depth: 30.8 m
- CGBS size: w/l/h - 94m/92m/54m
- Concrete volume: 28,000 m3
- Rebar quantity: 12,000 t
- Post tensioning: 1,000 t
- Mechanical Outf.: 1,800 t
- Structural steel: 1,900 t
- Oil production: ~70,000 b/d
- Associated gas: ~100 MMscf/d

**LUN-A Concrete Gravity Base Structure Slide 6**

**Key Facts**
- Topside weight: ~26,000 t
- Water depth: 48.2 m
- CGBS size: w/l/h – 105m/88m/72m
- Concrete volume: 35,000 m3
- Rebar quantity: 15,000 t
- Post tensioning: 1,300 t
- Mechanical Outf.: 2,700 t
- Structural steel: 2,500 t
- Gas production: ~52 million m3/d
- Peak liquids and condensate: ~8,000m3 /d (34,000 b/d)
- Peak oil: ~2,500 m3/d (16,000 b/d)
The Resting Place for Sakhalin II CGBS

Service Location Slide 7

Tow 960 naut. miles to Sakhalin II Field location in 18 Days at 2.5 knots

The Concrete for the CGBS

ANCON’s first involvement for Aker Kvaerner on site was January 2004 with a site visit by the author.

This was prior to commencement of any construction. The casting basin was largely complete and preparations were at an early stage for the bases for both platforms. On arrival there was no snow, however, that soon changed.

Casting Location for Lun A Photo 5

The concrete plants were erected and about to be commissioned. There are two identical plants (manufactured in Finland) with overhead bins and twin shaft mixers. The plants were separate, however, the cementitious materials could be transferred from one plant to another, if necessary.

Site Concrete Batch Plants Photo 6
Consultancy activities involved the resourcing and assessment of stone and sand for concrete production. Winter had set in and the sand operation had frozen over and the need to source additional and alternative sand was paramount.

**Kwarts Sand Frozen Over Jan 2004 Photo 7**

A local hard rock quarry had been selected and as the existing crushing plant was inadequate, a new crushing plant had been ordered from Moscow. Quarry consultancy support was then provided by ANCON. Crushing commenced late February 2004.

**S43 Plant In Operation Photo 8**

February and March had programed mix design development through the batch plant and a range of trial mixes to correlate setting time to retarder dosage rate.

It was necessary to retard the concrete for both the base slabs and cells. Cell slip form concrete was retarded for up to order 21 hours. With the base slabs it was required to have to order 18 hours retardation because of the size of the pours and the wet front. Base slab pours were to order 1500 – 2000m³ and in many cases it took 12 hours for the fresh concrete to meet up to the previously placed concrete. Of course, despite the cold weather in March, it was still windy and the surface of the fresh concrete was prone to drying on the surface and consequently large amount of aliphatic alcohol were used to control evaporation of moisture from the fresh concrete.

**Base Slabs Lun A Photo 10**

The project QC department had extensive Inspection and Test Plans with continuous inspection and testing from site and material supplier locations. In addition to that the Quarry Producers provided visual inspection of the product from the new plant!!!
The concrete specifications had a number of criteria, the most important being:

- Base and roof slabs and cells required a C60 (cube) at 28 days and a maximum W/C of 0.45.
- The shaft also had a C60 (cube) at 28 days and a W/C of 0.4 maximum.

The shafts are to be in the ice zone in sub artic sea and each year will be subject to the passing of some 4000km of ice, which will have a significant effect on abrasion and impact. To protect against such conditions – stainless steel casing will be fitted to the shafts.

The first cell wall pour on Lun A commenced on 13 May and finished on May 30. It was a little behind schedule, however, a great success. On this first pour of 2000m³, in a most complicated slip form, there were numerous learning curves and challenges to be overcome. Labour came from Korea, China, Russia and other countries. Both language and logistics were major challenges, all overcome despite a few anxious moments. The experience and management style of Aker Kvaerner was paramount in the success of this and future pours.

The reinforcement in some sections was as high as 6%.

**Heavy reinforcement in cells Photo 11**

Progress on the project has been excellent with all milestones met and all the slip forms for cells on Lun A were completed prior to end of July. The first slip form on PAB commenced in July.

The project has a QC department with an on site laboratory to support and assist both the Construction and Concrete Discipline sections with relevant support on QC for materials and construction.

ANCON has two concrete consultants located on site.

**OTHER INTERNATIONAL PROJECTS**

ANCON and the author have worked on a number of other notable projects in Asia and Russia and these include:

- Baiyoke 2 Tower in Bangkok (87 levels);
- BP Nan Con Son Gas Storage Facility in Vietnam;
- RCBC Towers in Manila;
- Tsing Ma Bridge Litigation in Hong Kong and London;
- Construction of High Quality Floors in Kuala Lumpur and Penang;
- LNG Storage facility at Yuzhno – Sakhalin Island in Far East Russia.
LESSONS LEARNED FROM SUCH PROJECTS

These include, however, are not limited to:

- Encourage the prospective client to engage support well in advance of project commencement;
- Ensure effective communication especially with different languages;
- Be ever so respectful and considerate of Nationals from other countries and their culture;
- Never, take anything for granted;
- Always at least double check everything;
- Always fully investigate local materials, concrete and practice;
- Introduce your technology carefully!!!!!
- Always inform the client when something is wrong, or that could be improved. The challenge is to do it without embarrassing or annoying the client. Always advise the client in writing if it is a serious matter.

OUTCOMES AND REWARDS

They are many. A successful project is by far the best reward for all involved. Being part of the team that achieved success is most gratifying. Working with people of all different cultures is rewarding.

Involvement in the Aker Kvaerner Sakhalin II Project has been of great interest. The efforts that the Norwegians have gone to create teamwork amongst all the site staff and particularly Russian and foreign workers has been nothing short of excellent. Their actions and achievements in the author’s opinion is most commendable.

Being involved in successful projects leads to other projects and this is a key outcome objective for the ANCON group.

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