PBL GROUP NEWSLETTER

WE STRENGTHEN YOUR STRUCTURES

Volume 3, Issue3 July 2009

Message from the Editor

Dear Readers,

This issue 3 will highlight on the interesting projects in India and Cambodia. Also included in this issue is the new PBL anchorage design and development.

The first project we will take you to fly across Indian Ocean to South Asia Continent for visiting Tandur Village, Rangareddy district of Andhrapradesh near Hyderabad, India. M/s Gannon Dunkerly Ltd. was awarded to construct entire structure part and has awarded Tech9 Engineering, specialist PT agency to be responsible for the PT work for the tallest Silo.

Then, moving through Mekong River to the neighboring country of Thailand for highlighting the construction of the Swan Bridge in Phnom Penh, Cambodia. The bridge structure was architecturally designed to the swan shape by using stayed cables to carry the design load and using post tensioning system for the main box girder, ribbed beams and deck slabs. Now its structural part has been successfully completed.

In Thailand we would like to present the development of new anchorage system with their test reports for SF205, 305, 405, 505, 605, 206, 306, 406 and 506. These new anchorages have compact sizes than the ones currently in use while efficiencies are better and saving in cost.

Finally, our senior staff and design engineers will report their activities in Phnom Penh during they visited the projects in Cambodia in the end of July upto the beginning of August.

Joy
Editor

Look out for the upcoming publication

- LATEST PT DESIGN TECHNOLOGIES
- SEMINARS AND WORK SHOPS
- STATE-OF-THE-ART DESIGNS
- UPDATES AND FOLLOW-UPS FROM THIS ISSUE
- PBL SOCIAL EVENTS

Tandur Silo, India

M/s Penna cement industries Limited a leading cement industry in Southern India, proposed to build a modern cement plant near Tandur Village, Rangareddy district of Andhrapradesh near Hyderabad having a capacity of 4,500 T.P.D.

"M/s Penna cement industries Limited a leading cement indystry in Southern India proposed to build a modern cement plant having a capacity 4,500 T.P.D., spread over a huge area of 70 hectares."

M/s Penna cement Industries has awarded the construction contract of cement plant to M/s Gannon Dunkerly Ltd. to construct entire structural part including clinker silo. M/s Gannon Dunkerly identified Tech9 Engineering as a specialist PT agency and decided to award the PT scope of works to Tech9 Engineering.

Designing of all structures including clinker silo was carried out by M/s Bhagawati designs Pvt Limited, a well known structural consultants in India.

The total plant spreaded over a huge area of 70 hectares including grinding units and chiller plants and a clinker silo. The project started on 15 January 2009 and finished on 15 June 2009.

Inside this issue:

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Tandur Silo, India

"Wall structure around the dozer entry is specially designed to take care of loads developed due to earthmoving equipment movement and internal pressures."

Structural Features

Clinker storage silo of this plant was important structure of 31 m height and 40 m diameter with a wall thickness of 400 mm. The entire circular SILO was divided by 6 equally angled RIBS (A, B, C, D, E and F) at every 60 degree to locate the pre-stressing tendon live ends.

From +0.600 m level to +4.600 m level an opening of 4.500 m x 4.500 m provided for hydraulic excavators/dozer to enter the silo for handling the CLINKER.

Wall structure around the dozer entry was specially designed to take care of loads developed due to earthmoving equipment movement and internal pressures.

Silo view during slip forming construction

PT in the Project

As a part of designing the circular wall structure, the entire pre-stressing design was carried out by M/s Bhagwati and the requirement of PT anchorages and system was decided as follows.

From –0.650 to +0.600 level 1 tendon with PBL M705 system circularly terminated to odd and even numbered tendons (odd indicated A, C & E Ribs and even indicated B, D & F Ribs). Each normal pre-stressing cable consisted 2 semi circular segments (anchored into alternate stressing Ribs).

View of Rib D during stressing

Structural Design

All the tendons were designed to be PBL M705 system. All the tendons were stressed from both ends up to 75% of UTS of strands using multiple hydraulic jacks and the dozer entry short length tendons stressed from end.

PT Parameter:

PT strands 12.7 mm conforming was 14268 CL II

Sheathings : 50 mm ID suitable for M705 systems "DROSS BACH" type flexible equivalent rolled out of 0.3 mm thick bright metal strips.

- From +0.600 m to +3.955 level the tendons were spaced at every 230 mm.
- From +3.955 m to +8.205 m level the tendons were spaced at every 250 mm.
- From +8.205 m to +12.405 m level the tendons were spaced at every 300 mm.
- From 12.405 m to +14.505 m level the tendons were spaced at every 350 mm.
- From 14.505 m to +17.705 m level the tendons were spaced at every 400 mm.
- From 17.705 m to +20.705 m level the tendons were spaced at every 500 mm.
- From 20.705 m to +23.705 m level the tendons were spaced at every 600 mm.
- From 23.705 m to +25.305 m level the tendons were spaced at every 800 mm.
- From 25.305 and beyond the structure was done by RC.

During stressing tendon elongations have been checked and recorded.

View of Rib E during concreting

Construction Sequence:

- Installation: Tendons installed till the Dozer entry level initially and the wall was casted by conventional methods.
- Slip form installation: After casting of dozer level slip form for circular structure installed and parallel PT installation was done.

Tandur Silo, India

- Slip forming: During slip forming day/night shift organized for continuous concrete programs. Every level PT tendon anchorages installed carefully and PT strands inserted.
- Curing: After completion of concrete, 28 days curing was allowed to the structure.
- Stressing: Stressing was carried out with multiple jacks from both ends of tendons.
- Grouting: Grouting of tendons was carried out as per standard with pressure grout pumps.

PBL anchorage M705 after stressing

View of silo during final stage of stressing

Project Team Work:

The project was led by Mr.Padma Rao who is a senior supervisor of Tech9 Engineering supported by 4 foremen and PT workers of 25 each for shift.

PT installation was done on day/night shift basis to cope up with slip forming construction speed. Stressing was carried out with two sets of 200 ton jacks and power packs simultaneously from both sides of Ribs. The biggest challenge of the project was stressing at heights above 20 meters with strong winds over the entire plan area in mid summer. Safety of workmen involved climbing and lifting heavy jacks was a big task and the entire activity of stressing 246 tendons with 492 live ends was completed in just 20 days with real spirit of team work by Tech9 and the project works coordinated by PM of GDC Mr.Pandey and Mr.Kamalakar.

For HO, Operations Director Mr.BV Nagarajkumar took responsibility of complete coordination required for material planning, manpower deployment and equipment deployment. He closely monitored the project and visited frequently to tackle any construction issue during the project duration.

Thanks to the entire team of Penna cements and GDCL who rendered their cooperation during nights and days to complete to PT activities successfully.

Contributed by: Mr. BV Nagarajkumar, a Operation Director of Tech9 Engineering Solutions Pvt Ltd., India

The Swan Bridge, Cambodia

Coming closer towards the end of the Swan Bridge Project which was earlier reported in our newsletter volume 1 issue 4 published and distributed in December 2007 its structural part has now been completed.

It was the belief of Chinese in the past that the dragon and the swan symbolized the power, honour, and gracefulness that was why one of the bridges connecting Phnom Penh mainland to one of the islands in Mekong River being under development by Canadia Bank in Cambodia was architecturally designed to the swan shape. The bridge which situated not far from the House of Parliament was intended to serve the traffic for those residents living and doing business on the island while commuting to the main land and vice versa.

"It was the belief of Chinese in the past that the dragon and the swan symbolized the power, honour and gracefulness that was why one of the bridges in Phnom Penh was designed to the swan shape."

Structural Feature

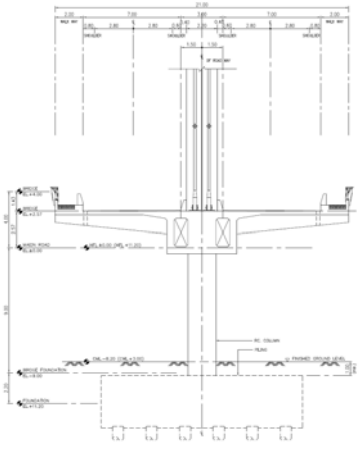
The bridge structure was designed using stayed cables to hold the live load of HS 20-44 truck load according to AASHTO standards and using post-tensioning system for the main box girder, ribbed beams, and deck slabs.

The bridge geometry was designed with a profile grade of 8.90% at one abutment end and declined down towards the middle of the bridge and finished at 8.16% at the other opposite abutment end. The bridge elevation was designed in such a way that the road surface was safely higher than the water level during the flood season.

The Swan Bridge, Cambodia

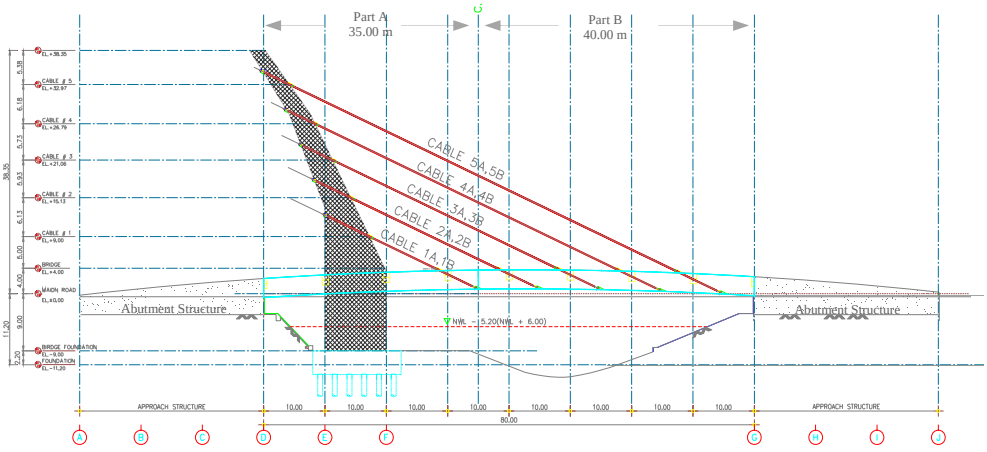
"The most interesting aspect of the bridge was the sequence of construction and the way of the scaffoldings were set up."

The bridge structure comprised footings, abutments, pylon, rib beams and deck slabs. The roadway width was 17.00 m. The total width including sidewalk was 21.00 m. The pylon footings rest on 32 ϕ 0.80 m bored piles. Each abutment was 30 m long and the main box girder spanned over 80 m length with the pylon center locating at 15 m from one of the girder ends. As the 10 cables were attached to one side of the pylon it formed unbalance single-plane stayed cable. The pylon structure was 35.00 m high. The cross-section of the pylon varied from 2.00 x 10.00 m at the footing to 2.00 x 2.54 m at the top and the main girder section was 3.00 x 5.00 m (h x w) with 2-regtangular cells inside.



Bridge cross section

The most interesting aspect of the bridge was the sequence of construction and the way the scaffoldings were set up. The concrete piles were laid horizontally in rows and used for supports of the scaffoldings. Underneath the concrete pile was the improved soil foundation in layers by means of mechanical vibrator. The work was done quite neatly so that concreting of the main beam, rib beams and deck slabs was possible even though these piles and lower parts of scaffoldings stayed underneath the water for months.



Bridge Geometry

View of completed deck

In order to ensure the structure was not over-stressed during the construction, calculation checks were made for every step of the construction process.

Construction Sequence

The sequence of construction after abutment walls were completed and bottom and side formwork were prepared was as follows.

- Installation of rebars and PT Tendons according to the profile as designed then casting main box girder for part A
- Stressing/Grouting tendons for Part A
  - longitudinal ducts in webs
  - transverse and longitudinal ducts at top flange
  - grouting longitudinal ducts No. 9 & 10 in main box
  - grouting transverse and longitudinal ducts at top flange
- Installation of rebars and PT system in the pylon

PT tendon stressing

- Casting the pylon
- Installation of rebars and PT system for rib beams and deck slabs for Part A
- Casting rib beams and deck slabs for Part A then

The Swan Bridge, Cambodia

"Now the final architectural parts are under construction. Once complete the swan head will be ready for installation to the pylon top structure."

- stressing tendons in rib beams 50%
- stressing deck slabs 50%
- stressing rib beams further up to 100%
- stressing deck slabs further up to 100%
- grouting tendons in rib beams and deck slabs Part A

- Installation of Pot Bearings at girder end adjacent to the abutment
- casting main box girder, part B
- Stressing longitudinal tendons in the main box girders and then longitudinal and transverse tendons at the girder top
- Installation of rebars and PT work in rib beams and deck slab, part B

Concreting of the top part of box beam

- Casting rib beam & deck slab, part B then
  - grouting rib beams and deck slab, part B
  - stressing rib beams 50%
  - stressing deck slab 50%
  - stressing rib beam further up to 100%
  - stressing deck slab further up to 100%
- Grouting tendon No. 1 to 8 and No.11 to 18
- Grouting the same for part B
- Dismantling of temporary supports under only main box girder
- Erection of temporary supports for installation of stay cable 1A and 1B
- Installation and stressing cable 1A and 1B

Cable duct installation

- Repeating the previous 2 steps for cable 2A, 2B, 3A, 3B, 4A and 4B with stressing sequence
- Repeating the previous 2 steps for cable 5A and 5B with stressing sequence
- Restressing cable 1A to 4B using 300 ton jack up to 264 ton force
- Restressing cable 5A to 5B the same manner up to 228 ton force
- Casting of pour strip at deck slab then the structure was completed.

The swan head for installing to the top of the bridge pylon top

Now the final architectural parts are under construction. Once complete the swan head will be ready for installation to the pylon top structure.

Bridge pylon top for swan head installation

Application for PT System

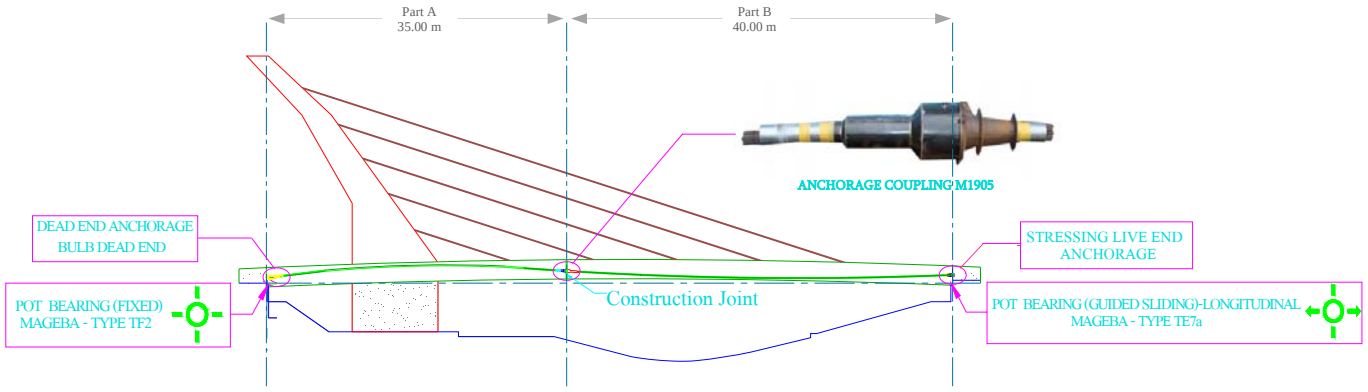
As for the main girder, PBL anchorages type M1905 & 2206 have been used for longitudinal tendons, rib beams and stayed cable. The strands for these cables were galvanized PT strands and the anchorage couplers with PE trumpets were used for the extension of tendons from main box girder first cast of 35 m length (part A) to the second cast of 45 m length (part B). PBL anchorages type SF305, 405 and 505 were used for the deck slabs PT of this project.

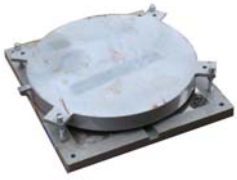
Project Team Work

The construction of the Swan Bridge was successfully completed by the following professional team work.

PBL Group Ltd. have contributed for the structural design, PT material supply and supervision of the PT construction while Canadia Bank Ltd. engaged in the construction by arranging the Project Manager, Mr.Touch Samnang, Project Engi-

The Swan Bridge, Cambodia





Pot bearing

Type & Size	Pot Bearing with Anchor Bolts		
	Vertical		Horizontal
	Loads (KN)		Loads (KN)
	$N_{Rd,\,max}$	$N_{Rd,\,min}$	$V_{vRd,\,max}$
TE 7a	11,207	2,536	1,422
TF 2	1,706	683	460

View of the Swan Bridge

neer, Mr.Meng Chamroeun, and Construction Manager, Mr.Soeum Angkeareasey and by provision of the construction team and workers for PT work and monitoring of this project.

Contributed by: Mr.Patibhan Ariyadej, Project Director of PBL Group Ltd.
: Mr.Arthit Ortantikul, Design Engineer of PBL Group Ltd.

New Compact PBL SF Anchorage

Having been participating in PT field activity for our 20 years PBL Group Ltd. never stop innovation. In order to enhance post-tensioning application PBL Group Ltd. have come up with the design for new sets of anchorage plates and heads SF205, 305, 405, 505 and 605 for 0.5" strand series and SF206, 306, 406 and 506 for 0.6" strand series which will cover wide range of post-tensioning application in construction industry at present.

"In order to enhance post-tensioning application PBL Group Ltd. have come up with the design for the new sets of anchorage for 0.5" strand and 0.6" strand."

The new anchorages design resulted in stronger and more compact shape of anchorage which can serve force transfer function as well as the original design while the friction loss is less as a result of the new configuration.

Concrete test blocks were designed and cast according to the specification in BS4447 in order for the well recognized third party, Structural Engineering Laboratory, School of Engineering and Technology from the Asian Institute of Technology (AIT), Thailand to come and to perform the test to determine the performance of these prestressing anchorages for post-tensioning construction according to BS4447:1973.

New Anchorage SF505

New Compact PBL SF Anchorage

Test Specification

In order to comply with this standard, single anchorages when tested with a tendon of a quality not lower than the lowest characteristic strength specified in BS2691 or BS3617 or BS4486 or BS4757 shall have the following minimum performance in at least 3 consecutive tests.

"With the sucessful design and test result PBL Group's clients now can enjoy the new compact development which shall offer a better and more economic solution for PT anchorage system and make saving cost."

- The actual efficiency of the anchored tendon shall not be lower than 92%.
- The percentage elongation at maximum load shall not be less than 1.8%.

Test of load efficiency and of elongation of the anchored tendon

Preparation of Test Specimens

Strand according to BS3617 for either 0.5" or 0.6" series of suitable lengths for each type of anchors were cut and inserted into the duct and anchorage plates already cast and embedded in the test block for each type of anchorage. The two strand ends were held by each corresponding type of anchorage heads with proper compact wedges installed.

Test Procedure

The calibrated hydraulic jack and the "Power Team" hydraulic pump fitted with the "MANO" pressure gauge were used for giving test loads to the anchorage sets.

Setting the dial gauges to measure elongation of the wire strand

The dial gauge capable of reading to 0.01 mm were installed in order to measure strand elongation. The tests were conduct at ambient temperature. The test loads for each type were increased approximately from 25% to 50% to 75% and over 92% and the elongation were measured.

Tensile testing machine

Test Results

The performance of the specimens were judged against the following criteria specification BS4447:1973. There were no cracks or any damage found on test at all types of new compact anchorage sets and test box while the applied loads exceeded 92% of the strand ultimate load and strand elongations equal or exceeded 1.8% therefore AIT, Thailand have issued PBL Group Ltd. the certified test reports for the new compact anchorage sets.

The summary of tests for compact anchorages shown as the following table:

Anchorage Type	Test Block Size (mmxmmxmm)	Jack & Pump	Percentage of Capacity (%)	Tensile Load (ton)
SF205	450 (w) x 3,040 (L) x 350 (T)	Jack: J&A no. 2006-192 Pump: "Power Team" no. 334029 Pressure gauge: no.073953051	96	17.98
SF305	350 (w) x 3,040 (L) x 350 (T)	Jack: J&A no. 2006-192 Pump: "Power Team" no. 334029 Pressure gauge: no.073953051	96	17.98
SF405	450 (w) x 3,040 (L) x 400 (T)	Jack: J&A no. 2006-192 Pump: "Power Team" no. 334029 Pressure gauge: no.073953051	96	17.98
SF505	500 (w) x 3,040 (L) x 400 (T)	Jack: J&A no. 2006-192 Pump: "Power Team" no. 334029 Pressure gauge: no.073953051	96	17.98
SF605	500 (w) x 3,000 (L) x 400 (T)	Jack: J&A no. 2006-192 Pump: "Power Team" no. 334029 Pressure gauge: no.073953051	96	17.98
SF206	450 (w) x 3,040 (L) x 350 (T)	Jack: J&A no. V240103 (042) Pump: "Power Team" no. 34033 (042) Pressure gauge: no.073953051	95	25.66
SF306	450 (w) x 3,040 (L) x 410 (T)	Jack: J&A no. V240103 (042) Pump: "Power Team" no. 34033 (042) Pressure gauge: no.073953051	95	25.66
SF406	500 (w) x 3,040 (L) x 400 (T)	Jack: J&A no. V240103 (042) Pump: "Power Team" no. 34033 (042) Pressure gauge: no.073953051	95	25.66
SF506	500 (w) x 3,000 (L) x 400 (T)	Jack: J&A no. V240103 (042) Pump: "Power Team" no. 34033 (042) Pressure gauge: no.073953051	95	25.66

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New Compact PBL SF Anchorage

With the successful design and test results, PBL Group's clients now can enjoy the new development which shall offer a better and more economic solution for post tensioning anchorage system and shall make saving for cost.

Contributed by: Asian Institute of Technology (AIT), Thailand

Visiting the Projects in Phnom Penh

During the end of July and the beginning of August PBL Group assigned senior staff and design engineers to travel to Cambodia. The mission aimed at

- promoting customer relationship
- concluding the new PT projects.

Mr.Patibhan Ariyadej along with Mr.Nonpavit Vararatsameewong, Engineer Jettasik Wattanasing, Engineer Arthit Ortantikul have made their trips to visit project managers who in charged of the construction projects just substantially completed recently. The team have visited Mr.Chea Vuthy the project manager of OCIC 30-storey highrise building owned by Canadia Bank. The building is now at the final touch up stage and is expected to be inaugurated soon.

Then the team went to see Mr.Kakda who has been the project manager of Maekong Condo, 18 storey twin highrise condominium buildings. Not only supervised and controlled the construction of these buildings but Mr.Kakda did the PT design for the buildings with PBL Group's advice.

The team also went to visit Mr.Touch Samnang, the project manager of the "Swan Bridge" project together with Mr.Meng Chamroeun, the project engineer and Mr.Soeum Angkeareasey, the construction manager. They were quite happy about the outcome of the construction and agreed they have learned a lot from the PT construction. The project is also at the final stage as they are working on the architectural swan head. Once this is ready it will be installed up at the top of the pylon. With final painting and a little touch up the bridge will be totally completed.

Construction of RC ground floor and columns supporting PT 1st floor at LCC convention building

The team went to meet Dr.Kong Vannarith, a project director, and Mr.Darawan, project manager, for Phnom Penh LCC convention building owned by the government and LCC was awarded the contract for construction. Discussion was made on advantage of PT structure compared to RC structure, methodology and sequence of construction preparatory work, various regulations concerning importation of PT materials to Cambodia, responsibility of each party and the final contract agreement was reached and signed by LCC and PBL Group.

The team moved on to meet Mr.Sok Thy, the project manager for Rose Condominium of 2-26 storey buildings and 2-27 story buildings belonging to Canadia Bank with the PT area total upto 40,000 sq.m. The team reported to the project manager of their preparatory work regarding the design, material procurement and delivery, and supervision intended to be executed for the project. One of the important points of PT work execution i.e. assignment of specific workers to do stressing and grouting in order to ensure smooth operation was emphasis during discussion.

The team ran short of time and could not meet the project managers of Happiness City and Toeuk Thla Plaza.

We hope with new activities coming up in the near future we can inform our readers more of what have been going on in Phnom Penh in our next issue.