해외정보 및 출장보고서

382  National Road No.3 Rehabilitation Project in Cambodia Phase 2 (Structure Part)  
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This paper describes the features of structural design including planning and inventory, detail design of project bridge connecting Phnom Pehn and Kampot City in Cambodia. The bridges were examined by visual inspection of experienced bridge engineers. Including observation with tape measure, vibration and level of crack with naked eyes were inspected. The plans for bridges aimed at economy on bridge renovation, so small bridges were examined to be changed to box culverts, if necessary, and large bridges were investigated to be reused, if possible, depending on the status and appropriateness of bridge width. The project comprises the rehabilitation of 137.5 km including 27 No. of bridges and 30 No. of drainage box culverts which are planned at the beginning time of detail design stage. There are total 27 bridges, which were planned as two types of PSC Deck and RC Slab for cost and maintenance reasons. Except the 9 continuous bridges, those are simple bridge. The other short length bridges are designed as box culverts considering a site situation. The type of piers is track shaped RC pier and abutment is inverse T-type. Direct or pile foundation is applied for the foundations of bridges considering soil investigation results and piles were designed as pre-cast reinforced concrete piles.
CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF THE PROJECT

Roads in the Royal Government of Cambodia are well categorized into National Road, other National Road, Provincial Road, etc. and the network of Roads also has been well developed with Phnom Penh, the capital city of Cambodia, as a center of the network. However, much of them have been severely damaged by protracted civil war and flooding, and lack of maintenance.

Accordingly during the past decade, Cambodia government has improved its road infrastructure remarkably with the financial assistance of international Funding Agencies-ADB, World Bank and EDCF of Republic of Korea etc. Among those foreign funds, EDCF has contributed for the improvement of an important part of National Road No.3 from Kampot to Trapang Ropou. But more important section of National Road No.3 between Phnom Penh to Kampot, the nation’s highest priority section for infrastructure development, has been temporarily repaired after 2000 flood damage and waiting for further comprehensive improvement.

1.2 Project Summary

- Executing Agency: Ministry of Public Works and Transport (MPWT)
- Implemented by: Project Implementation Unit (PIU) RN3-II
- Loan from: Export-Import (EXIM) Bank of Korea resources of Economic Development Cooperation Fund (EDCF)
- Date of Loan Agreement: May 18, 2007
- Valid date of Disbursement: 42 Months after Effective Date of Loan Agreement
- Consultant: Korea Consultants Inter-
national Ltd. in association with Yooshin Engineering Corporation (Korea) in sub-consultant with Khmer Consultants Engineering Corporation Ltd (Cambodia) and VIDO Engineering Consultants Co., Ltd. (Cambodia)

- Contractor : Not Designated Yet

1.3 Object of the Project

The overall object of the project is to support Cambodia’s economic development as specified;

a) Restore access between rural markets consumer centers, and to major tourist attraction
b) Increase the public mobility and regional economic development
c) Open countryside to tourist, and
d) Reduce transportation costs.

At detailed design stage followings are under procedure;

a) Detailed design of road alignment, cross sections, drainage, bridge construction, pavement and road safety facilities.
b) Specifications and provisions necessary for construction works.
c) Cost estimates and implementation programs.
d) Bidding documents for contract of civil works.

1.4 Project Description

The MPWT is the Project Executing Agency (PEA) for the project and has established a Project Implementation Unit (PIU) for this project. The PIU has been organized by the MPWT with qualified engineers, accountant and supporting staffs.

The project comprises the rehabilitation of 137.5 km including 27 No. of bridges and 30 No. of drainage box culverts which are planned at the beginning time of detail design stage. No big changes are planned for the horizontal alignment of the road but because of areas of flooding the vertical alignment will be raised up approximately 0.5~1.0 m of its height.

Design Criteria at Detail Design Stage;

(1) Road Length : 137.5 Km
(2) Roadway Width : 11.0m
   - Carriageway : 7.0m(2@3.5m)
   - Shoulders : 4.0m(2@2.0m)
(3) No. of Bridges : 575m/27 Nos.
(4) Bridge Width : Rural Area 11.0m(22 Nos.)
                  Urban Area 12.0m (5 Nos.)
(5) Drainage structures
- Box Culvert : 375.0m/30 Nos.
- Pipe Culvert : 1,238m/80 Nos.

(6) Pavement:
- Carriageway : Double Bituminous Surface Treatment (DBST)
- Shoulders : Single Bituminous Surface Treatment (SBST)

CHAPTER 2
Bridge Investigations

The investigation of structures within this project route, national road No.3 has been undertaken 3 times, such as the first site investigation for 3 days from November 7, 2007, the second for 3 days from January 10, 2008 after detailed survey, and the last on February 5, 2008 for an additional examination.

2.1 Inspection Methods

Site investigation for all the bridges was performed according to references in Table 2.2.1, and inspection methods are described as below,

- Inspecting structural conditions of existing structures,
- Observing overall shapes of bridges and judging structural stability,
- Feeling degree of vibration on traffic for deciding serviceability,
- Observing scour damage and flood level on structures,
- Interviewing with local officials and village resident opinions on rough flood level.

2.2 Inspection Results

2.2.1 Condition of Superstructure

There are 51 existing bridges including new two ones, which consist of 43 bridges having span length less than 20m and 8 bridges more than 20m.

<table>
<thead>
<tr>
<th>Type</th>
<th>Span Length</th>
<th>Numbers</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSC BEAM</td>
<td>7~40m</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCS, RCT</td>
<td>4~14m</td>
<td>35</td>
<td></td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>S.T truss GR.</td>
<td>12~50m</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.T plate GR.</td>
<td>52.5m</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary of Condition</td>
<td>51</td>
<td>3</td>
<td></td>
<td>48</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.2.1 Summary of Condition of the Existing Bridges
1) PSC Beam Bridges

Mostly, no vibration was felt on traffic of heavy vehicles and no particular problem for conditions of superstructure was found. Therefore, it is judged that long-term repetitive fatigue has no effect on the safety.

Although a small amount of soil was piled at joint between girders, and deflection occurred somewhat in the middle of girder in some bridges, it was considered that there will be no problem for long-term safety, and faces of concrete are also satisfactory. Thus, new bridge (Slakou Bridge) and a bridge across reservoir (7 JANUARY Bridge) was concluded to remain. However in case of 7 JANUARY bridge, because 15~20 years passed away from its completion, design products were not kept normally, and precise load-carrying capacity was impossible to be verified. Therefore it is judged that a sign panel to prevent heavy vehicles from passing need to be installed for the future maintenance.
2) RCS and RCT Beam Bridges

Most bridges are obsolete. 50% of them have serious deterioration, 30% of them reveal some concrete falling off at side of section, exposure and erosion of rebar and large crack, and 20% of them have excessive white efflorescence. Thus, all of RCS beam bridges need to be replaced.

3) Steel Truss Girder Bridges

Some vibration was felt on traffic of heavy vehicles, and width of bridge is required to be expanded. Also, because the deck is the type of temporary bridge made of steel plate or wood, the bridges seem to have overall problems. Some hand rails of superstructure were also investigated to be broken from vehicle collisions, and it is judged that all the bridges are necessary to be replaced.
4) Steel Plate Girder Bridge
The new bridge across reservoir constructed by Japanese is in good condition, is designed for live load HS20, and has expansion joints and bearings.

2.2.2 Condition of substructure
Most bridges have the type of substructure either installed by concrete pile foundations under abutments and piers or reinforced by steel on existing broken piers for steel bridges.

Firstly, many piles and concrete piers installed on the ground were seriously exposed, damage level of piers and abutments were critical. Its width is not enough on building superstructures. Therefore it is judged that it is impossible to use existing substructures.
Secondly, reinforcing temporarily above existing piers or constructing temporary piers with steel has much risk now. Thus it is judged that existing structures have to be immediately removed, and permanent substructures have to be installed.

Except those above, in case of concrete protection installed in the bottom of channel, aggregate is exposed by effect of scouring, and others of them are found to be lost. Also, wing walls (or wing retaining walls) of abutment are made of concrete and stone, but the level of damage is serious, so it is judged that construction was very poor.
CHAPTER 3
SELECTION OF ROUTES & BRIDGE DESIGN

3.1 General

The project road as the National Road No. 3 which starts from Phnom Penh, the capital of Cambodia, and ends in Kampot, the tourism city on the southern coastal via Takeo is a 2-lane road and 137.5km long in total.

Because of topographic effects, good alignment with long straight section and big curve radius corresponds to 96 percent while poor alignment with small curve radius and inappropriate design speed at hilly sections corresponds to only 4 percent.

(3) Current Status of the Existing Bridges on the Road No. 3 (No5~No13, No15~ No35 del)

<table>
<thead>
<tr>
<th>NO.</th>
<th>STA</th>
<th>Type</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Clearance propriety</th>
<th>Structure Condition</th>
<th>Width Propriety</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18+644</td>
<td>RC.SLAB</td>
<td>6.5</td>
<td>8.9</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Replacement (enlarge inner space)</td>
</tr>
<tr>
<td>2</td>
<td>21+120</td>
<td>RC.SLAB</td>
<td>4.2</td>
<td>6.7</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Replacement (enlarge inner space)</td>
</tr>
<tr>
<td>3</td>
<td>22+702</td>
<td>RC.SLAB</td>
<td>37.2</td>
<td>9.8</td>
<td>Y</td>
<td>P</td>
<td>Y</td>
<td>Replacement (upward vertical align.)</td>
</tr>
<tr>
<td>4</td>
<td>23+749</td>
<td>PSC.BEAM</td>
<td>78.0</td>
<td>10.0</td>
<td>Y</td>
<td>G</td>
<td>Y</td>
<td>Use (Good condition)</td>
</tr>
<tr>
<td>14</td>
<td>65+796</td>
<td>PSC.BEAM</td>
<td>100.0</td>
<td>12.0</td>
<td>Y</td>
<td>G</td>
<td>Y</td>
<td>Use (Good condition)</td>
</tr>
<tr>
<td>36</td>
<td>105+847</td>
<td>ST.DECK</td>
<td>48.4</td>
<td>5.6</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Replacement (upward vertical align.)</td>
</tr>
<tr>
<td>37</td>
<td>106+928</td>
<td>ST.DECK</td>
<td>18.3</td>
<td>4.0</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Replacement (upward vertical align.)</td>
</tr>
<tr>
<td>43</td>
<td>121+196</td>
<td>RC.SLAB</td>
<td>10.0</td>
<td>4.7</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Replacement (enlarge inner space)</td>
</tr>
<tr>
<td>47</td>
<td>136+717</td>
<td>RC.SLAB</td>
<td>12.0</td>
<td>7.3</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Replacement (upward vertical align.)</td>
</tr>
<tr>
<td>48</td>
<td>138+057</td>
<td>RC.SLAB</td>
<td>14.3</td>
<td>6.7</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Replacement (upward vertical align.)</td>
</tr>
<tr>
<td>49</td>
<td>140+055</td>
<td>RC.SLAB</td>
<td>6.5</td>
<td>5.8</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Replacement (enlarge inner space)</td>
</tr>
<tr>
<td>50</td>
<td>143+740</td>
<td>RC.SLAB</td>
<td>15.3</td>
<td>5.8</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Replacement (enlarge width)</td>
</tr>
<tr>
<td>51</td>
<td>145+721</td>
<td>ST.DECK</td>
<td>24.1</td>
<td>5.2</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Replacement (enlarge width)</td>
</tr>
</tbody>
</table>
3.2 Route Selection

The routes for the study road were selected in consideration of technical, economical and environmental aspects as well as in conformity with local situation on the basis of sufficient site observation and investigations. In addition optimum routes were selected through enough consultation with Cambodia government (MPWT).

<table>
<thead>
<tr>
<th>Classification</th>
<th>Length (km)</th>
<th>Percentage (%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use Existing Alignment</td>
<td>133.4</td>
<td>97.0</td>
<td></td>
</tr>
<tr>
<td>Change Existing Alignment</td>
<td>4.1</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>137.5</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

3.3 Bridge DESIGN

3.3.1 General

The tasks performed to complete the project's detailed design for bridges include the following:
- Survey of existing structures,
- Study of results of soil investigation,
- Detailed design of 27 bridges and 30 box culverts.
Preparation of relevant documentation including special specification, bill of quantities and drawings,
Assessment of quantities and cost estimates

Most of the existing bridges along the project road shall be replaced due to their poor conditions, lack of load carrying capacity and narrow widths. So, it is planned to design and construct the new bridges at the existing bridge sites.

According to the preliminary design based on the site survey, optimum types for superstructure, substructure and foundation were selected.

3.3.2 Design Specifications

Design specifications for local condition, which comply with the Bridge Design Standard of Cambodia in 2003 and that of Korea in 2005, are specified under agreement with the Ministry of Public Works and Transportation (MPWT) in Kingdom of Cambodia.

(1) Reference Specifications

Bridges were designed in accordance with the following standards and requirements;
- Specification for Bridges on the Road (Korea, 2005)
- Concrete Structure Design Manual (Korea, 2003)
- Standard Specifications for Highway Bridges (AASHTO, 2002)

(2) Design Concept

For the detailed design of bridges the allowable stress design and the ultimate strength design method were applied as follows;

1) PSC Structure

The allowable stress design method was applied and the safety was checked by the ultimate strength design method.

2) Reinforced Concrete Structures

The ultimate strength design method was applied and the serviceability was checked by the allowable stress design method.

(3) Bridge Clearance for Water Level

The bridge clearance for river is checked according to Korean Standard Specifications for River (2003) (see Table 7.7.1) because it is not clearly specified in design specifications of Cambodia.
Table 3.3.1 Criteria of Minimum Bridge Clearance for Water Level

<table>
<thead>
<tr>
<th>Design Flow Rate (m3/s)</th>
<th>Minimum Bridge Clearance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 200</td>
<td>More than 0.6</td>
</tr>
<tr>
<td>200 ~ 500</td>
<td>More than 0.8</td>
</tr>
<tr>
<td>500 ~ 2,000</td>
<td>More than 1.0</td>
</tr>
</tbody>
</table>

(4) Transverse Cross Section of Bridge

Standard cross section composition

(5) Design Loads

1) General

The Bridge Design Standard of Cambodia is applied to design loads such as dead load, wind load, temperature load, shrinkage, and earthquake load.
2) Live Load
DB24 load, which is equal to AASHTO HS20-44 highway loading plus 30% overload, is considered as live load considering the safety for heavy weight trucks.

3) Wind Load
Average wind speed is specified in the Bridge Design Standard of Cambodia and wind load is calculated by CAM PW 04.102.99 Table 7.7.2

<table>
<thead>
<tr>
<th>Region</th>
<th>Description</th>
<th>Serviceability Limit State (Vs)</th>
<th>Ultimate Limit State (Vu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Coastal Region within 50 km from the Coast</td>
<td>35</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Coastal Region for 50 to 100 km from the Coast</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>B</td>
<td>Coastal Region beyond 100 km from the Coast and FlatLandRegion</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>C</td>
<td>High Land</td>
<td>35</td>
<td>45</td>
</tr>
</tbody>
</table>

3.3.3 Bridge Design

(1) General
All bridges are investigated to renovation except for two bridges built by Japan and 7 JANUARY bridge.

The investigation was performed in three aspects below.
- Repair, reinforcement, and replacement are examined according to the condition of bridge.
- Superstructures of bridges with insufficient clearance are considered to be replaced according to rise of design level.
- Bridges with narrow width are considered to be expanded.

Considering these aspects, preliminary construction cost is estimated. In addition, for bridges No.1~27, feasibilities for the selection of bridge are studied and then, detailed design was carried out according to final structure type.

(2) Structure Type Investigation
The design of bridges was based upon the following investigations.
- Site investigation of the condition of the existing structures, carried out by design consultants.
- Soil investigations of the condition of...
bridge site, carried out by design consultants.
- High Water Level investigation, carried out by design consultants.

According to site investigation, some structure types are applicable as follows.

1) Superstructure

Small bridges less than 20m in length make up 90% of total bridges within the project route, and concrete materials abounds in this region. Therefore, RC Slab bridges made of concrete and PSC deck bridges for areas of insufficient clearance are judged economical.

Reinforced concrete bridges including RC Slab bridge mainly applied to the small bridges, have availability for construction materials in local region and simple construction. Especially, the incidental expenses for superstructure can be reduced

Figure 3.3.2 Typical Section of PSC deck

<table>
<thead>
<tr>
<th>(a) PSC deck 10m</th>
<th>(b) PSC deck 12m</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="a" alt="Diagram" /></td>
<td><img src="b" alt="Diagram" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(c) PSC deck 15m</th>
<th>(d) PSC deck 25m</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="c" alt="Diagram" /></td>
<td><img src="d" alt="Diagram" /></td>
</tr>
</tbody>
</table>

Typical Section of PSC deck
because most bridges in this route have low height of bridge (less than 4m: 80%, less than 3m: 70%). Therefore, these are economical types of bridge on the assumption that construction quality will be kept up for the cast in-situ.

PSC deck bridge, whose girder height is from 38 to 100 cm and low relatively compared with the other type of concrete bridge. The section of beam is squared beam and is constructed by connection between each side. This type is occasionally used due to simplicity of construction in local area and insufficient bridge clearance. Figure 3.3.2 shows the typical section of PSC deck.

PSC beam is produced as 23 m beam length (thickness: 140 cm) and 28 m (thickness: 183 cm) in local area and is largely applied to the long span bridges. This type, however, has a high girder and can cause the vertical alignment of road to be lifted higher. Therefore, such a bridge type should be cautiously applied to this route mainly passing by the flat lands and small bridges have insufficient clearance.

Steel plate girder requires large quantities of steel, of which the whole quantity has to be imported in local area. Therefore, this is not the economical bridge type except for a particular case. Long-span bridge, however, has the advantage of reduction in the cost of substructure owing to the lesser weight of superstructure and diminishment in pier.

2) Substructure

On the site investigation of the area, the piers of low bridges were eliminated on account of the planning to simple span bridges and the front side of abutment was reinforced with concrete for restraint of scour.

For long span continuous bridge, cross section of its pier was planned to track type shape, which is considered terrains and channels, in order that water may flow fluently. In addition, T-shape pier was applied to all bridge for the maximum water cross section.

For the increase in traffic volume and minimum effort in maintenance, reinforced concrete would be applied to all substructures.

3) Foundation

a) Footing

This foundation type is appropriate for the shallow bed rock and reliable soil support layer. If the scour is expected, footing should be installed below scour depth.
b) Pile

In local area, there are pile manufacture companies which have wide experience in foundation construction for bridge and its products are of good quality. Square section is mostly used and major standard dimension is 400 x 400 mm.

Ground investigation report is referred to for more details which contain investigation results and structural calculations.

(3) Structure Plan

1) Vertical Alignment

Need for superstructure replacement was investigated according to rise of design level of superstructure for bridges to be potentially inundated and to have low clearances.

When design level should be higher, height of a substructure should be also raised, and that makes construction work more difficult. Thus, in case of replacing a superstructure of an existing bridge, it is decided that a substructure as well as a superstructure will be replaced considering maintenance in the future even if the substructure is in good condition.

2) Expansion

The main concept is setting up minimum width criterion and utilizing as many existing bridges as possible if their widths are above the criterion. Some bridges with widths below the criterion are planned to be expanded according to a new standard width.

Although an existing bridge has lower deck width than standard one, if that have no influence on the design speed and passage of vehicles, the bridge may be utilized so that construction cost can be reduced. In the project route, all bridges which can be utilized have superstructures wide enough to have 2 lanes, so widening work is not needed.

3) Conclusion

It is concluded that bridge plan is divided into two categories, replacing and keeping existing bridges, considering local condition, economical efficiency, and maintenance cost rise as well as what are investigated above.

It is decided that two existing PSC bridges and one existing steel plate girder bridge should be kept and the others should be replaced considering the safety and the economical efficiency with maintenance.
(4) Result of Detailed Design for Bridges

1) PSC deck bridge

PSC DECK Bridge with Multi-Concrete girders of the hollow type which is produced in advance from site, is structural type that can move with all of superstructure by longitudinal and transverse tension. This bridge minimizes field works because concrete site-placing of deck plate is not needed. In result, it will be much advantageous to insure quality and reduce construction cost.

PSC deck bridges consist of the various spans (10m~25m) and two widths (11m, 12m).

<table>
<thead>
<tr>
<th>Current status</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO.</td>
<td>STA</td>
</tr>
<tr>
<td>1</td>
<td>18+644</td>
</tr>
<tr>
<td>2</td>
<td>21+120</td>
</tr>
<tr>
<td>3</td>
<td>22+702</td>
</tr>
<tr>
<td>4</td>
<td>23+749</td>
</tr>
<tr>
<td>5</td>
<td>23+917</td>
</tr>
<tr>
<td>6</td>
<td>24+900</td>
</tr>
<tr>
<td>7</td>
<td>25+735</td>
</tr>
<tr>
<td>8</td>
<td>31+358</td>
</tr>
<tr>
<td>49</td>
<td>140+055</td>
</tr>
<tr>
<td>50</td>
<td>143+740</td>
</tr>
<tr>
<td>51</td>
<td>145+721</td>
</tr>
</tbody>
</table>

1) Superstructure
   - Design Concrete Strength: 45 MPa
   - Reinforced bar yield strength: 400 MPa
   - PC Strand 12.7mm, Ultimate Strength: 1,900 MPa
   - Yield strength: 1,600 MPa

2) Substructure
   - Abutment type: inverse T type
   - Pier type: T type with track type section
   - Foundation: direct or pre-cast standard square(400x40cm)RC pile
   - Design Concrete Strength: 24 MPa
   - Reinforced bar yield strength: 300 MPa
Table 3.3.4 Summary for Planning of PSC Deck Bridges (No.4~No.20 etc part del)

<table>
<thead>
<tr>
<th>NO.</th>
<th>Station</th>
<th>Bridge Name</th>
<th>Length(m)</th>
<th>Width(m)</th>
<th>Height(m)</th>
<th>Inner Void(m)</th>
<th>Unit Weight(kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22+702</td>
<td>Prek Thnot</td>
<td>10+25+10=45</td>
<td></td>
<td>1.0, 0.38</td>
<td>0.6, 0.152</td>
<td>297.50, 54.0</td>
</tr>
<tr>
<td>2</td>
<td>24+900</td>
<td>Pralai 63</td>
<td>15</td>
<td></td>
<td>0.54</td>
<td>0.25</td>
<td>107.54</td>
</tr>
<tr>
<td>3</td>
<td>31+358</td>
<td>Posath</td>
<td>12</td>
<td></td>
<td>0.49</td>
<td>0.23</td>
<td>77.42</td>
</tr>
<tr>
<td>7</td>
<td>66+695</td>
<td>Slakou Khang Thbong</td>
<td>15+25+15=55</td>
<td></td>
<td>1.0, 0.54</td>
<td>0.6, 0.25</td>
<td>297.50, 107.54</td>
</tr>
<tr>
<td>21</td>
<td>138+057</td>
<td>Prah Ponlear</td>
<td>25</td>
<td>12</td>
<td>1.0</td>
<td>0.6</td>
<td>309.24</td>
</tr>
</tbody>
</table>

2) RC slab bridge

For the span around 10~15m, RC slab bridge is the most economical. The planning of 6 new RC slabs bridges is summarized.

Table 3.3.5 Summary for Planning of RC Slab Bridges (3 part del.)

<table>
<thead>
<tr>
<th>NO.</th>
<th>Station</th>
<th>Bridge Name</th>
<th>Length(m)</th>
<th>Width(m)</th>
<th>Height(m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25+735</td>
<td>Daeum Trang</td>
<td>12.5+15+12.5=40</td>
<td>12</td>
<td>1.1</td>
</tr>
<tr>
<td>5</td>
<td>130+137</td>
<td>Krorsar</td>
<td>2@10=20</td>
<td>11</td>
<td>1.0</td>
</tr>
<tr>
<td>6</td>
<td>143+740</td>
<td>Sras Pang</td>
<td>2@10=20</td>
<td>11</td>
<td>1.0</td>
</tr>
</tbody>
</table>

- Design concrete strength : 27 MPa
- Reinforced bar yield strength : 400 MPa
- Abutment type : Inverse T-type
- Pier type : T type with track type section
- Foundation : direct or precast standard square (40X40cm) RC pile

3) Box culvert

The section of box culvert was decided considering a waterway width and a flow. The minimum height of soil cover above the box culvert is 40cm and the effect of live load on the box culvert was verified by structural analysis.

The constructions of 30 box culverts.

- Design Concrete strength : 24 MPa
- Reinforced bar yield strength : 300 MPa
CHAPTER 4
맞음달(캄보디아 3번국도 설계를 마침)

2007년 11월 6일에 업무를 시작하였으며, 사무실은 MPWT(Ministry of Public Works and Transport)내에서 근무하였다.
여러 가지 본사에서 일하는 것과는 차이가 있다고 판단합니다. 현장담당은 전 구간을 3차례 왕복을 하였으며 필요시 수시로 나가서 현장을 봤다. 외국이사에서 우여곡절도 많았다. 현장조사 시 교량에서 떨어지는 사고도 발생하여 병원에서 진찰도 받았고 도로조사 때에는 식사할 곳이 없어 라면으로 식사를 했다. 하지만 조사가 끝나고 감옷에서 먹은 게 요리와 백주 맛은 일품이었다.
이러저러한 일을 많이 겪었으나 조사 설계시 수위조사 및 기타조사를 철저하게 하였고, 현장에서 조사한 자료와 본사에서 수행한 구조물계산 및 도면을 바탕으로 설계를 완료할 수 있었다. 본사에서 본 과업을 수행해준 부원들에게도 고마움을 전합니다.

구조물의 형식 선정은 공사비의 제약으로 충분히 KCI의 전적 팀과 상의하였으며 캄보디아 정부와도 협의 후 결정하도록 하였다.
유신에서는 2명이 파견이 되었으며 본사의 지원을 받아 수행하였다.
고성조이 되어있지만 KCI의 김재중 단장님이 김태승 고문님 이하 지반에 유연책 전무님과 도로에 전용우 이사님이 잘 도와주어 구조물(박스)과 교량의 설계를 완료하게 되었고, ’08 3, 5, 귀국길에 오르게 되었다.
현재는 유신감리가 책임감리를 수행하고 있으며 시공 완료 후 무사히 귀국하기 바라는 바이다.
조금 어수선 마음은 시공비용의 부족으로 상정적인 교량의 설계는 못하였으며, 차후에 유신이 교량 설계시 유신 구조부의 장점인 특수(현수교, 사장교, 아치교 등)교의 설계와 시공을 하여 메롱강에 놓기 를 바라는 바입니다.