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THESIS

A STUDY OF CONSTRUCTION COST OF CONCRETE BRIDGE STRUCTURE

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the Requirements for the Degree of
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Costs of concrete bridge construction projects have been vital information to all project stakeholders, especially the Department of Rural Roads under the Ministry of Transport and Communications in Thailand. As a result, cost management is probably the most significant component in managing all construction bridge projects. However, relevant data and necessary information are not stored and managed systematically and effectively. This means that there is a need for a research study in the area of cost management for concrete bridge construction projects. The main objectives of this study are (1) to explore cost components of concrete bridge construction projects, (2) to establish tables and formula to display the quantity of materials used for different types of concrete bridges, and (3) to determine indexes used to measure changes in the costs of bridge construction projects in each year, using the escalation factor (K-factor). In this research study, data of 155 construction projects in Thailand were collected and subsequently analyzed. The results show the cost components of the concrete bridges including 53.38 percents of super-structure, and 46.62 percents of sub-structure. The results also present tables used to determine the quantity of super-structure materials, and graphs employed to determine the quantity of sub-structure materials. In addition, the results represent indexes exercised to predict the costs of bridge construction projects in different years, compared to the one in the year 2001.

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Pisuth Sutthipoon

January 2006

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (continue)

Page

LIST OF TABLES

LIST OF TABLES (continue)

LIST OF FIGURES

Figure **Page**

Appendix Figure

A STUDY OF CONSTRUCTION COST OF CONCRETE BRIDGE STRUCTURE

INTRODUCTION

General

The development of infrastructure today plays a crucial role in developing the country in the area of economy, society and politics. Bridge construction is carried out for transportation and traffic purposes, on which the government invests a huge budget each year. Therefore, selecting the type of bridge that is most suitable for constructing will help save the cost of bridge construction. In order to meet quality and high level of construction standard, environmental effects, methods of construction, material sources, beauty and relevant specification and regulations must be taken into consideration before bridge construction takes place. Constructing a bridge is one of the main responsibilities of the Department of Rural Roads which is incharge of a yearly budget for many bridge construction projects. This is why the researcher studied and investigated overall cost of bridge construction and standard types of bridges of the Department of Rural Road.

Scope of Study

This research directly involves costs of concrete bridges. The researcher employed the standard drawings of the bridges of the Department of Rural Roads under the Ministry of Transport and Communications of Thailand, part of which are shown in Appendix B. Two major parts of the concrete bridges include super-structures and sub-structures. Super-structure consisted of decks, sidewalks, rails, and miscellaneous items such as painting, signs, and foundations of lighting poles. Decks can be classified into four types including R.C. Slab with a span length of 10.00 meters, plank-girders with a span length of 10.00 meters, box-girders with a span length of 20.00 meters, and I-girders with a span length of 20.00 and 30.00 meters. The plank-, box-, and I-girders involve three main construction processes including constructing cast-in-place concrete girders, an installation of the girders,

and placing of the concrete topping. The drawings also show that the sidewalks have a width of 1.50 meters each side. Rails have a normal height of 1.20 meters.

The other part of concrete bridges is sub-structure including piles, piers, and miscellaneous items. According to the standard drawings, the cross-section of the concrete pile is 0.40 x 0.40 meters, whereas its length varies for each project site. Piers are composed of footings, columns, and capbeams, whereas these have a variety of sizes. However, typical lengths of the piers are 3, 6, 9, 12, and 15 meters. According to the construction process, piles construction engages execution of the driven piles, and installation of temporary structures such as formworks. And, piers involve abutments (edge piers) and mid piers, whereas the miscellaneous items of the substructures include painting the piers, cleaning, and others.

According to the types of super-structure, four types of concrete bridges are used for this study. These include R.C. Slab, Plank–girder, Box-girder and I-girder. The researcher studied each type of concrete bridge, and materials of several types of concrete bridges, the length of bridge span, and the cost of the bridge per unit of deck plan area. More importantly, the escalation factor (K-factor) usually used in the governmental projects is also exercised to estimate the construction cost of concrete bridges constructed in different years. In this study, data of concrete-bridge construction projects in Thailand between 2001 and 2004 were gathered. A total of 155 construction projects were used and analyzed for this research study.

Objective

The objectives of this study are as follows:

1. To explore cost components of concrete bridge construction projects.

2. To devise table and a formula for calculating the quantity of materials used in bridge construction

3. To determine cost adjustment factor (F_{ca}) used to measure changes in the costs of bridge construction projects in each year, using the escalation factor (K-factor).

LITERATURE REVIEWS

Classification of Bridges

Generally, bridges can be divided into a number of categories, depending upon what sort of criteria, for instance, type, age, design load, design, material type, function, span length and system, is used in classification.

Ahuja (1982) and Victor (1983) recommended that for bridges can be essentially classified in many ways, as listed below:

A. According to the road level in relation to the highest flood level of the river below, particularly for a highway bridge, as high-level or submersible bridge.

B. According to the position of the bridge floor relative to the superstructure as deck, through, semi-through, half-through or suspended bridge.

C. According to function or purpose as aqueduct (canal over a river), viaduct (road or railway over a valley), foot bridge, pedestrian, highway, road-cum-rail or a pipeline bridge.

D. According to the form or type of superstructure as slab, girder, beam, truss, arch, cable stayed or suspension bridge.

E. According to degree of redundancy as determinate or indeterminate bridge.

F. According to span length as culvert (less than 8m), minor bridge (8 to 30m), major bridge (above 30m) or a long span bridge (120m).

G. According to the interspan relations as simple, continuous or cantilever bridge.

H. According to the method of connections to the different parts of the superstructure, especially for steel construction, as pin-connected, riveted or welded bridge.

I. According to materials used in construction of superstructure as timber, masonry, iron, steel, reinforced concrete, prestressed concrete, composite or Aluminum Bridge.

J. According to the method of clearance for navigation as high-level, movable-bascule, movable-swing or transporter bridge.

K. According to the anticipated type of service and duration of use as permanent, temporary, military (pontoon, Bailey) bridge.

Part of a Bridge

Like other types of infrastructure such as building, power supplies, dam and road, a bridge consists of a number of different components performing a variety of functions. In bridge engineering, a bridge can be broadly divided into two primary parts, as listed below:

1. Super-structure
2. Sub-structure

To make it easy to understand, it can be said that the super-structure of a bridge is analogous to a single storey building roof and substructure to that of walls, columns and foundations supporting it.

Bindra (1982) said that super-structure is the system that is supported by substructure. It consists of structural members carrying a communication route. Thus, handrails, guard stones and flooring supported by any structural system such as beams, girders, arches and cables above the level of bearings constitutes the structure.

Alagia (1983) suggested that substructure is a supporting system for superstructure. It is comprised of the following:

1. Abutments
2. Piers and abutment piers
3. Wing walls
4. Foundations for the piers and abutments

The other main parts of bridge structure are approaches, bearings and river training works, like aprons, revetment for slopes at abutments, etc.

Cost Estimation

In estimating construction costs, there are many methods available to a project estimator. The selection of the method of cost estimation is more often than not based on not only the estimator's preference and/or judgment, but also the suitability of the method for the construction. The following are two methods of cost estimation widely used among the estimators.

1. Preliminary Estimation
2. Final Estimation

Pilcher (1992) suggested that there are commonly three main methods of preliminary cost estimation utilized by engineers and estimators worldwide. These methods are as follows:

Unit Method

The unit method is based upon the cost for a functional unit, for instance, the cost of storage facilities per worker in a factory, per tone of material stored, per tenant accommodated in a flat, per million litres of water retained in a reservoir, per occupant of an office building, per unit of a product stored, etc. The estimated cost of the work is then the capacity, in unit terms, multiplied by the cost per unit.

Cube Method

The principle of the cube method is based upon historical costs, which are updated when necessary, of one cubic meter volume of a building or structure. In this method, the volume of the building or structure is calculated in cubic meters and subsequently multiplied by the cost of one cubic meter, making the estimated cost of the work.

Square Meter Method

Like the cube method, the principle square meter method is to use historical costs to calculate the estimated cost of a building or structure. However, the difference is that this method is based upon the superficial floors area of the building or structure, not the volume.

Peurifoy (1989) recommended that there are generally five major steps needed for preparing a full estimate of construction costs. These steps are as follows:

1. Review the scope of the project, considering the effects of location, security, traffic, available storage space, etc, on construction costs.

2. Determine quantities, performing a detailed material quantity take-off and unit pricing for all work items in the project and recording the quantity, and the unit of measure for each item.

3. Calculate material prices, extending material costs:

$$\text{Material Cost} = \text{Quantity} \times \text{Unit Price}$$

4. Calculate labor prices, based on possible labor production rates and crew sizes, determining labor costs:

$$\text{Labor Cost} = \frac{\text{Quantity x Labor Rate}}{\text{Labor Production Rate}}$$

5. Calculate equipment prices, based on probable equipment production rates and equipment spreads, determining equipment costs:

$$\text{Equipment Cost} = \frac{\text{Quantity x Equipment Rate}}{\text{Equipment Production Rate}}$$

Problems

Lammant (1990) and Raina (1988) recommended that regardless of what sort of method was used, how accurate the calculation was and how many times checking have been done, the estimate of construction costs can never be an exact science. This is because the final selection of the unit costs will, in most cases, be based on the estimator's experience and judgment. Additionally, unit prices are concerned with the particular problem under consideration and will usually show change with an alteration in the character of the problem. This implies that there are a number of factors affecting unit prices, and thus overall construction costs.

Factors Affecting Construction Cost

As explained above, there are essentially several key factors that can have significant impact on overall construction costs. In order for the estimator to obtain an accurate estimate of construction cost of the project, these factors must be taken into consideration when calculating the cost of each work item done. Lammant (1990), James (1990) and Raina (1988) suggested some of these factors as can be seen below.

- Weather and soil conditions
- Groundwater and water controls
- The degree of complexity of the project
- The size and type of a construction project

- The work method used in the project

- The competence of the job inspection and supervision

- Interruptions by strikes

- The availability of materials

- The amount of access available

- Union rules and Thai government specifications

- Difficulties in construction (e.g. extent of detours required, including their maintenance; whether construction is on a new alignment which may be undistributed by traffic, or whether the construction is in an urban area, thus handicapped by heavy traffic volumes, etc.)

- The availability of labor

- The quality of work required

- The quality of workmanship required

- The availability of skilled workers and the necessary equipment

- The size of the crews and equipment used relative to the quantity of works required

- Whether any major equipment is required to be bought afresh

- Contractor’s overhead expenses, profit margin and promotional expenses (whether any special provision to be built in)

- Whether there is abundance or scarcity of civil engineering works in the current market

- Economic climate in the country when costing the bid

- Location of work site with respect to the nearest rail and road head (effects on hauling and movement costs)

- The possibility of increase in material costs and labor wages during the currency of contract, e.g. inflation, rising fuel price, etc

- Current material costs in the market or as supplied

- Current labor wage rates

- The degree of cost control exercised

- The cost of transporting materials to a construction site, including all handling and storage

- Whether there is an allowance made for overtime work

- Whether there is the opportunity for repetitive operations

Cost Adjustment

According to Bureau of Trade and Economic Indices the accepted tender shall be adjusted in respect of the rise or fall in the indexed costs of constructional plant, diesel fuel, construction materials and other inputs to the works, by the application of a price adjustment factor (K_i) determined by formula as shown below. The adjustment shall apply only when the portion in excess of 4 per cent rise or fall in costs.

The formula for computation shall be:

When $K_I < 0.96$

$$P = (P_o) \times (0.96 - K_i)$$

Or when $K_I > 1.04$

$$P = (P_o) \times (K_i - 1.04)$$

Or when $0.96 \leq K_i \leq 1.04$

$$P = P_o$$

Where

P = Unit cost of works or cost of partial payment which will be paid to or recovered from the Contractor,

P_o = unit cost of works or cost of partial payment determined in accordance with the accepted tender rates and prices;

K_i = price adjustment factor to be used for adjusting the cost of applicable partial payment as computed from the relevant formula according to the type of word as follows:

Reinforced Concrete Structures, Piles, Bearing Unit, R.C. Box Culvert :

$$\mathbf{K = 0.30 + 0.10\ I_t/I_o + 0.15\ C_t/C_o + 0.20\ M_t/M_o + 0.25\ S_t/S_o}$$

Subscript letter "t" denoted the Index applicable in the month that the Contractor presents his statement for Monthly Progress Payment to the Employer through the Engineer.

Subscript letter "o" denotes the Index applicable in the month of the Tender Opening Date.

The following indices are established and published monthly by the Ministry of Commerce, Thailand.

Where K price adjustment factor.

M = Construction materials (exclude cement & steel)
S = Steel price index
C = Consumer price index of Thailand
I = General consumer price index of Thailand

The price adjustment factor (K_I) shall be computed to three places after the decimal point without any rounding up by calculating the ratio of the indices prior to the multiplication by the constant in the formula.

RESEARCH METHODOLOGIES

Research Procedure

There are eight consecutive steps in performing this research study as presented in Figure 1. These steps were conducted from 2004 to 2005. Each step was considerably and thoroughly conducted, and consequently findings from each would be used for later step. Details of these steps are presented below.

1. Literature Reviews: This step was to conduct a preliminary research on previous concrete-bridge construction studies in both Thailand and other countries. The studies included several textbooks, Thailand governmental transportation documents, and educational and engineering professional websites. This step covers the following related topics: definitions and classifications of bridges, components of concrete bridges, cost estimate, factors affecting construction costs, and analysis of cost estimate. Consequently, facts and useful research data were collected as shown in Literature Reviews, and these would be used as knowledge foundations for later steps.

2. Data Collection: This step was mainly to collect construction costs of reinforced-concrete bridge construction projects in Thailand between 2001 and 2004. The number of construction projects used for this study comes to 155 in total. Below is a table representing the number of construction projects in each year from 2001 to 2004, used in this research study.

Table 1 The number of projects used in this thesis between 2001 and 2004

Year	Number of Projects
2001	33
2002	41
2003	49
2004	32
Total	**155**

Significant data include Bill of Quantity (BOQ), bidding documents and concrete-bridge standard drawings. These valuable data were collected from the Department of Rural Roads, the Ministry of Transport and Communications, Thailand, and were stored in Microsoft Excel Version 2004 for further analyses.

3. Development of Cost Breaking Down Structure (CBS): After the literature reviews and data collection were performed, cost components of concrete-bridge construction from the gathered projects were developed in the form of CBS. It presented not only details of costs, but also an overview of construction project costs which help the construction manager to administer project costs. Also, acquired CBS for this study was used as a conceptional framework for further analyses and help focusing on specific component costs as desired.

4. Data Analysis: This step was taken to analyze data to satisfy the research objectives as presented in Introduction. Major research objectives include the following:

4.1 To explore cost components of concrete bridge construction projects.

4.2 To establish tables and formula to display the quantity of materials used for different types of concrete bridges.

4.3 To determine cost adjustment factor used to measure changes in the costs of bridge construction projects in each year, using the escalation factor (K-factor).

The first objective could be achieved by determining statistical means, whereas the second and third objectives were completed by the quantity of materials calculated from the standard drawings given by the Department of Rural Roads and the third objectives by using index from Bureau of Trade and Economic Indices.

5. Setup forcasting cost model

At this stage, the researcher devised tables and formula for calculating the quantity of materials. These table and formulas were sulsequently used as forcasting cost model

6. Verify the model

The researcher test the model on five selected projects. These projects are listed below.

1) Narathivat ; year 2003

- Bridge length = 350.00 m. ,width = 11.00 m.
- Type of super – structure :
  Plank – girder : Two – 10 meter – length span
  Box – girder : Six – 20 meter – length span
  I – girder : Seven – 30 meter – length span

2) Nakhon Si thammarat ; year 2003 , width =11.00 m.

- Bridge length = 100.00 m.
- Type of deck :
  Box – girder : Five – 20 – meter – length span

3) Lopburi ; year 2005

- Bridge length = 160.00 m., width = 11.00 m.
- Type of deck :
  R.C.Slab : Four – 10 – meter – length span
  Box – girder : Six – 20 – meter – length span

4) Chiang Rai ; year 2005

- Bridge length : 100.00 m. ,width = 11.00 m.
- Type of deck :
  Plank – girder ; Four – 10 – meter – length span
  Box – girder ; Three – 20 – meter – length span

5) Chiang Mai ; year 2005

- Bridge length : 100.00 m.
- Type of deck :
  Plank – girder ; Two – 10 – meter – length span
  Box – girder ; Two – 20 – meter – length span

7. Research Results: This step was to present research findings mostly from the analysis, which were basically related to the research objectives.

8. Conclusion and Recommendations: This step was conducted mainly to conclude the research study, and to represent research scopes and limitations for better use of the results. Also, this step presented significant recommendations for further research studies.

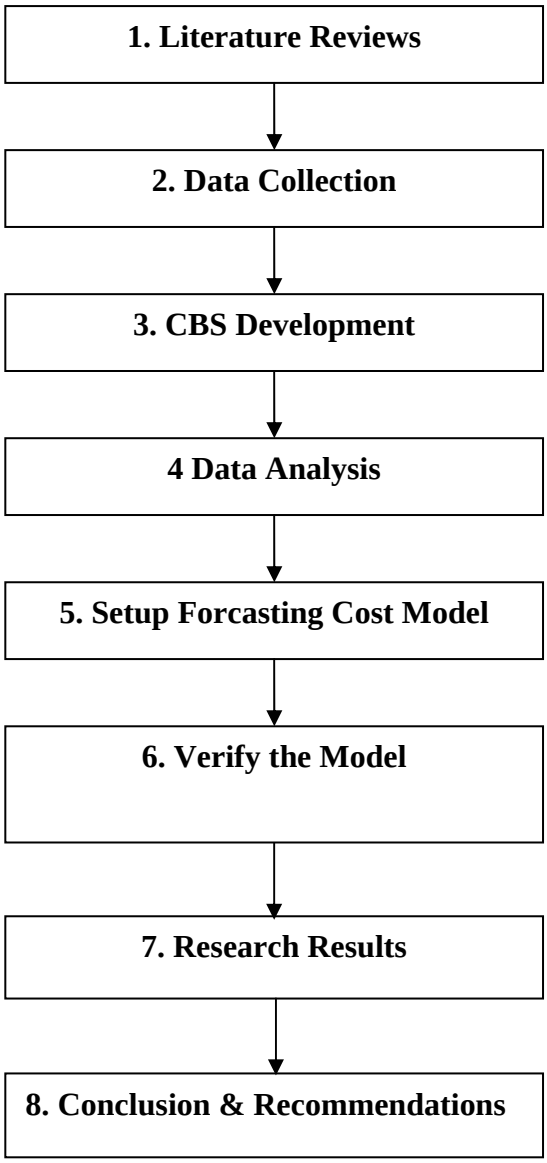

Figure 1 Procedure of research methodologies

Statistical Means

Rosenthal (2001) stated that an average is a value which is typical or representative of a set of data.

The Arithmetic Mean

The arithmetic mean or the mean of a set of N numbers $X_1, X_2, X_3, \ldots\ldots, X_N$ is denoted by $\overline{X}$ (read "X bar") and is defined as

$$\overline{X} = \frac{X_1 + X_2 + X_3 + \ldots + X_N}{N} = \frac{\Sigma X}{N}$$

The Standard Deviation

Rosenthal (2001) introduced the standard deviation is regarded as the most useful and most utilized measure of variability. The mean is the workhorse measure of central tendency. Likewise, the standard deviation is the workhorse measure of variability. Below is the best formula used to gain a comprehensive understanding of the standard deviation.

$$S_{samp} = \sqrt{\frac{\Sigma (X - \overline{X})^2}{N}}$$

In the above formula,

S_{samp} = Standard deviation of a sample

$\overline{X}$ = Mean

X = Score of an individual case

N = Sample size

Σ = Summation sign

The Variance

Rosenthal (2001) recommended that the formula used to calculate the variance makes use of squared deviations around the sample mean, like the formula for the standard deviation, The following is the first formula for the variance of a sample.

$$S^2_{samp} = \frac{\Sigma (X - \overline{X})^2}{N}$$

In this formula,

S^2_{samp} = Variance of a sample

RESULTS

Results come from an analysis of the cost of construction projects between 2001 – 2004.

The researcher divideds the cost of bridge construction into 2 main groups according to structure of a bridge. These are super–structure and sub–structure. The results reveal that the average percentage of the cost of super–structure and sub– structure is 54.34% and 45.66%, respectively, as can be seen in Table 2. This percentage is used to draw Cost Breakdown Structure (CBS) as shown in Figure 2.

Cost Component of Concrete Bridge Construction

Table 2 Average percentage of sub-structure cost and percentage of super-structure cost between 2001 and 2004

Year	Structure			
	Average % of Super – Structure Cost	STD	Average % of Sub - Structure Cost	STD
2001	53.11	5.17	46.86	5.17
2002	54.23	10.29	45.77	10.29
2003	53.87	8.92	46.13	8.92
2004	56.47	6.63	43.53	6.63
AVERAGE	**54.34**	**2.28**	**45.66**	**2.28**

STD = Standard deviation

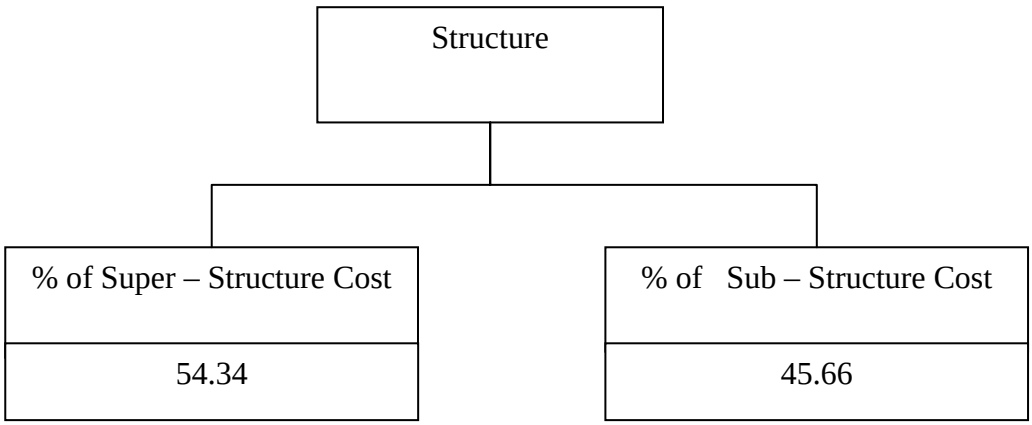

Figure 2 Average percentage of sub-structure cost and super-structure cost between 2001 and 2004

Super-structures

The super-structures comprise of decks, sidewalks, rails, miscellaneous items. Miscellaneous items mean painting of the rails, bridge signs, foundations of lighting systems, and others. According to the analysis, Table 3 shows that an average percentage of costs of decks, sidewalks, rails, and miscellaneous items is 85.76%, 6.75%, 6.33%, and 1.16%, respectively. And CBS of these results is shown in Figure 3.

Table 3 Average percentage of slab cost, sidewalk cost, rail cost and miscellaneous cost between 2001 and 2004

Year	Percentage of super – structure Cost						
	Average % of Deck Cost	**STD**	**Average % of Sidewalk Cost**	**STD**	**Average % of Rail Cost**	**STD**	**Average % of Miscellaneous Cost**
2001	86.27	4.20	7.28	3.71	5.63	0.95	0.82
2002	86.24	4.82	6.65	2.59	6.17	2.15	0.95
2003	85.62	4.82	6.51	2.59	6.69	2.14	1.18
2004	84.93	2.23	6.55	1.21	6.83	1.17	1.69
AVERAGE	**85.76**	**4.76**	**6.75**	**1.60**	**6.33**	**0.58**	**1.16**

STD = Standard deviation

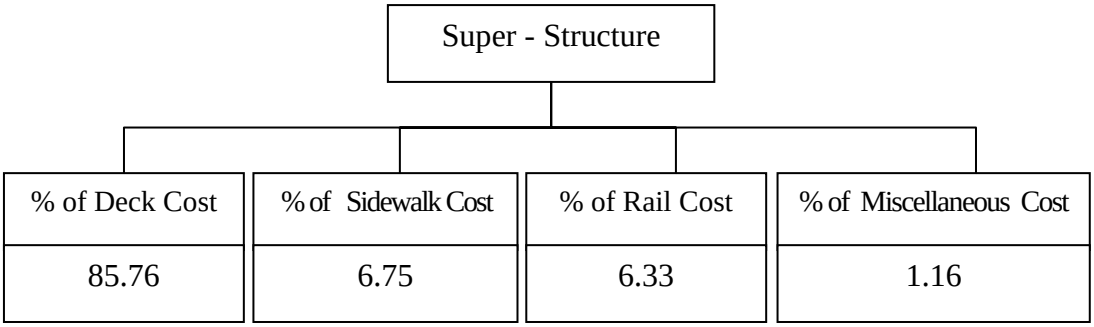

Figure 3 Average percentage of deck cost, sidewalk cost, rail cost and miscellaneous cost between 2001 and 2004

Sub-structures

Based on data collected from the year 2001 to 2004, the analysis regarding the sub-structure costs was conducted. The substructure includes piles, piers and footings, and miscellaneous items. Miscellaneous items consist of painting of the piers, cleaning, and others. Referring to Table 4, the result shows that an average cost of piles, piers and footings, and miscellaneous items is 49.07%, 50.16%, and 0.78%, respectively. CBS of the substructure is presented in Figure 4.

Table 4 Average percentage of pile cost, pier cost and miscellaneous cost between 2001 and 2004

Year	Percentage of sub – Structure Cost					
	Average % of Pile Cost	STD	Average % of Pier Cost	STD	Average % of Miscellaneous Cost	STD
2001	51.62	12.46	47.23	12.37	1.15	0.58
2002	46.53	16.33	52.23	16.33	1.23	0.61
2003	47.53	12.77	51.60	12.70	0.87	0.68
2004	44.69	13.90	54.55	13.38	0.72	0.28
AVERAGE	47.55	13.87	51.45	13.70	1.00	0.54

STD = Standard deviation

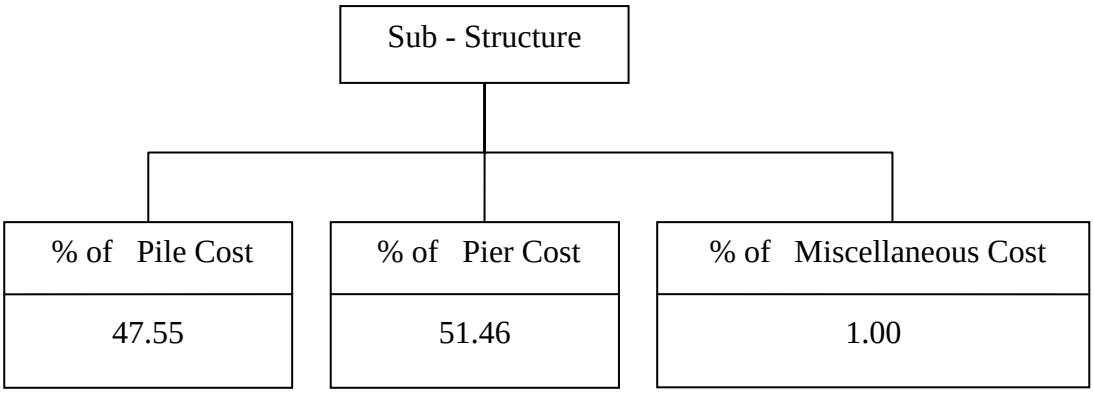

Figure 4 Average percentage of pile cost, pier cost and miscellaneous cost between 2001 and 2004

Quantity of Materials

The researcher has established tables and graphs to determine the quantity of construction materials (concrete, formwork and rebar) used in the construction of bridge super-structure and bridge sub-structure, respectively.

Super-structure

The super-structure of a bridge generally consists of deck, rail and sidewalk. According to the standard drawing of the Department of Rural Roads, it can be normally classified into five groups, as shown below:

1. RC slab span length 10.00 m. Depth 0.53 m.
2. Plank-girder span length 10.00 m. Depth 0.35 m.
3. Box-girder span length 20.00 m. Depth 0.70 m.
4. I-girder span length 20.00 m. Depth 1.20 m.
5. I-girder span length 30.00 m. Depth 1.70 m.

Table 5 to Table 9 show quantity of materials for r.c. slab, plank-girder, box-girder, and I-girder.

Table 5 Quantity of Super–structure material for R.C. slab deck

Item	Quantity of Materials		
	Concrete ($m.^3$)	**Formwork ($m.^2$)**	**Re-bar (kg.)**
Total / span	64	174	9,278
Average / m.	6.4	17.4	927.80

Note: (r.c. slab, Width 8.00 m., Span length 10.00 m., Depth 0.53 m.)

Table 6 Quantity of Super–structure material for plank-girder deck

Item	Quantity of Materials			
	Concrete ($m.^3$)	**Formwork ($m.^2$)**	**Re-bar (kg.)**	**PC wire/strand (kg.)**
Total / span	57	244	3,754	1,811
Average / m.	5.7	24.45	375	181

Note: (plank–girder,Width 8.00 m. , Span Length 10.00 m., Depth 0.35 m.)

Table 7 Quantity of Super–structure material for box-girder deck

Item	Quantity of Materials			
	Concrete ($m.^3$)	**Formwork ($m.^2$)**	**Re-bar (kg.)**	**PC wire/strand (kg.)**
Total / span	104	967	15,060	3,445
Average / m.	7.03	48.37	753	173

Note: (box–girder, Width 8.00 m., Span Length 20.00 m., Depth 0.70 m.)

Table 8 Quantity of Super–structure material for I-girder deck
(span length 20.00 m.)

Item	Quantity of Materials			
	Concrete ($m.^3$)	**Formwork ($m.^2$)**	**Re-bar (kg.)**	**PC wire/strand (kg.)**
Total / span	104	670	25,189	25,189
Average / m.	5.18	33.52	1,299	1,260

Note: (I–girder, Width 8.00 m., Span Length 20.00 m.,Depth 1.20 m.)

Table 9 shows quantity of material I-girder span length 30.00m.

Table 9 Quantity of Super–structure material for I-girder deck.
(span length 30.00 m.)

Item	Quantity of Materials			
	Concrete ($m.^3$)	**Formwork ($m.^2$)**	**Re-bar (kg.)**	**PC wire/strand (kg.)**
Total / span	175	38,832	25,968	4,843
Average / m.	5.85	30.17	1,295	162

Note: (I–girder, Width 8.00 m., Span Length 30.00 m. Dept 1.70 m.)

Sub – Structure

The substructure is made of pile, abutment and pier. The researcher has discovered a formula for calculating the quantity of materials for each of them as shown in table.

Pile

In this research, the length of a pile is separated into 4 groups;$7<L\leq13$m., $13<L\leq19$m., $19<L\leq25$m. and $25<L\leq28$m. (where L = pile length (m)). The objective of which is to invent formulas for calculating the quantity of materials for a pile. In this formula the quantity of material is proportionated to the length of a pile as shown in Table 10.

Table 10 Formulas for determining for quantity of material for pile.

Pile length (m.)	Concrete ($m.^3$)	Formwork ($m.^2$)	Rebars (kg.)
$7.00 < L \leq 13.00$	0.16L	1.2L + 1.6	20.172L + 34.000
$13.00 < L \leq 19.00$	0.16L	1.2L + 1.6	37.882L + 34.152
$19.00 < L \leq 25.00$	0.16L	1.2L + 1.6	37.882L + 34.302
$25.00 < L \leq 28.00$	0.16L	1.2L + 1.6	37.882L + 35.426

Where L = pile length (m.)

Abutment

According to the standard drawing of the Department of Rural Roads, abutment support deck span length is 10 meters and 20 meters. In this formula, the quantity of material is proportionated to the height of abutment as can be seen in Table 11.

Table 11 Formula for determining the quantity of material for abutment.

Materials	Formula	
	Pier span 10 m.	**Pier span 20 m.**
Concrete ($m.^3$)		
H ≤3	1.2H + 29.92	1.2H + 29.92
Formwork ($m.^2$)		
H ≤3	2.4H + 60.64	2.4H + 77.28
Rebars (kg.)		
H ≤ 3	212.52H + 2,847.9	238.15H + 3,140.1

Where H = Height of abutment (m.)

Pier

The structure of a pier is comprised of capbeam, column and footing. The researchers separated a pier into six groups according to span height as listed below:

- According to span length, pier span 10 + 10 m.,10 + 20 m.,10 + 30 m., 20+20 m.and 20+30 m.

- According to pier height , H < 3 m., 3 ≤ H < 6 m., 6 ≤ H < 9 m. , 9 ≤ H < 12 m. and 12 ≤ H < 15 m. (Where H = Height of pier)

Each of the formulas invented are designed to be used in conjunction with a certain range of span length. In these formulas as, the quantity of material is proportionated to the height of pier as can be seen in Table12.

Table 12 Formulas for determining the quantity of material for pier.

Pier span	10+10	10+20	10+30	20+20	20+30	30+30
Concrete ($m.^3$)						
$H < 3$	1.01H + 41.59	1.57H + 54.36	1.57H + 63.15	1.57H + 53.35	1.57H + 63.15	1.57H + 70.84
$3 \leq H < 6$	1.01H + 41.59	1.57H + 54.36	1.57H + 63.15	1.57H + 53.35	1.57H + 63.15	1.57H + 70.84
$6 \leq H < 9$	1.57H + 50.24	1.57H + 54.36	2.26H + 60.14	1.57H + 53.35	3.08H + 102.97	2.26H + 85.50
$9 \leq H < 12$	-	2.26H + 60.20	2.26H + 60.14	2.26H + 65.35	3.53H + 100.34	3.53H + 120.30
Formwork ($m.^2$)						
$H < 3$	5.03H + 53.64	6.28H + 76.31	6.28H + 75.35	6.28H + 39.12	6.28H + 75.35	6.28H + 71.22
$3 \leq H < 6$	5.03H + 53.64	6.28H + 76.31	6.28H + 75.35	6.28H + 39.12	6.28H + 75.35	6.28H + 71.22
$6 \leq H < 9$	6.28H + 76.31	6.28H + 76.31	7.54H + 76.01	6.28H + 39.12	6.28H + 75.35	7.54H + 83.48
$9 \leq H < 12$	-	7.54H + 76.01	7.54H + 76.01	7.54H + 76.01	9.42H + 100.72	9.42H + 110.08
Rebars (kg.)						
$H < 3$	128.02H + 471	203.74H + 6,275	292.29H + 8,292	248.12H + 6,320.1	354.2H + 6,163.6	469.39H + 10,752
$3 \leq H < 6$	180.41H + 4,100	345.42H + 7,221	292.29H + 8,292	380.84H + 7,072.7	354.2H + 6,163.6	469.39H + 10,752
$6 \leq H < 9$	230.18H + 5,240	451.66H + 7,694	380.80H + 8,340	451.68H + 7,360.5	380.8H + 8,240.2	474.27H + 14,303
$9 \leq H < 12$	-	472.27H + 8,140	380.80H + 10,450	472.27H + 8,490.2	640.8H + 10,952	710.38H + 17,200

Where H = height of pier (m.)

Test model

Project 1

Estimate quantity and cost of concrete bridge

Province: Narathiwat

Length of bridge	=	350.00 m.
Roadway	=	8.00 m.
Sidewalk	=	1.50 m

Super – structure

Type of deck:

- Plank – girder ; Two - 10 meters length span
- Box – girder ; Six - 20 meters length span
- I – girder ; Seven - 30 meters length span

Sub – structure

Pile : Size = 0.40 x 0.40 m.

- Length = 18.81 m., (16 piles)
- Length = 22.72 m., (316 piles)
- Length = 25.80 m., (8 piles)

Abutment ; Span 10 m.

P1 and P16 ; Height = 0.83 m.

Pier

Pier span 10 + 10 m. = 2 (P2, P15) ; height = 0.50 m.
Pier span 20 + 30 m = 2 (P5, P12) ; height = 0.61 m. .
Pier span 30 + 30 m. = 6 (P6, P7,…,P11); height = 2.95 m.
Pier span 20 + 20 m. = 4 (P3, P4, P13, P14); height = 0.90 m.

1. Determine the quantity of *super – structure* material

From table 6 quantity of super–structure material for plank-girder deck

Concrete	= 5.65	$m.^3/m.$
Formwork	= 24.45	$m.^2/m.$
Rebar	= 375.41	kg./m.
PC wire / strand	= 181.08	kg./m.

Quantity of Super–structure material for Plank – girder, two - 10 meters length span.

Concrete = 5.65 x 2 x 10
= 113 $m.^3$

Formwork = 24.45 x 2 x 10
= 488.4 $m.^2$

Rebar = 375.41 x 2 x 10
= 7,508 kg.

PC wire / strand = 181.08 x 4 x 10
= 3,622 kg.

From table 7 quantity of super–structure material for *Box – girder deck*

Concrete	= 7.03	$m.^3/m.$
Formwork	= 48.37	$m.^2/m.$
Rebar	= 753	kg./m.
PC wire / strand	= 173	kg./m.

Quantity of super–structure Material for *Box – girder deck* , six - 20 meters length span

Concrete = 7.03 x 6 x 20 $m.^3$
= 843.6 $m.^3$

Formwork = 48.37 x 6 x 20 $m.^2$
= 5,804.4 $m.^2$

Rebar = 753 x 6 x 20 kg.
= 90,359 kg.

PC wire / strand = 73 x 6 x 20 kg.
= 20,670 kg.

From table 9 quantity of super–structure material for I-girder deck

Concrete = 5.85 $m.^3$/m.
Formwork = 30.17 $m.^2$/m.
Rebar = 1,295 kg./m.
PC wire / strand = 162 kg./m.

Quantity of super–structure material for *I – girder deck,* seven - 30 meters length span

Concrete = 5.85 x 7 x 30 $m.^3$
= 1,228.5 $m.^3$

Formwork = 30.17 x 7 x 30 $m.^2$
= 6,335.7 $m.^2$

Rebar = 1,295 x 7 x 30 kg.
= 271,950 kg.

PC wire / strand = 162 x 7 x 30 kg.
= 34,020 kg.

Total quantity of material for super – structure

Concrete = 2,245 m.^{3}
Formwork = 12,629 m.^{3}
Rebar = 369,817 kg.
PC wire / strand = 58,312 kg.

2. Determine quantity of sub – structure material

Pile

Size = 0.40 x 0.40 m.
Length = 18.80 m. no.of pile = 16
Length = 22.72 m. no.of pile = 316
Length = 25.80 m. no.of pile = 8

Used formula from table 10 to determine quantity of material for pile

19.00 < L ≤ 25.00 m.; where L = pile length (m.)

Concrete (m.^{3}) = 0.16 L
Formwork (m.^{2}) = 1.2 L
Rebar (kg.) = 37.882 L + 34.152

- ***Pile length = 18.80 m. no. of pile = 16***

Concrete = 0.16L
= 0.16x18.80 = 3.01 m.^{3}

Formwork = 1.2 L
= (1.2x18.80) + 1.6 = 24.16 m.^{2}

Rebar = 37.882L + 34.152
= (37.882x18.80) +34.152
= 746.33 kg.

- ***Pile length = 22.72 m. ; no of pile = 316***

  Concrete = 0.16L

  = 0.16x22.72 = 3.64 $m.^3$

  Formwork = 1.2L + 1.6

  = (1.2 x 22.72) + 1.6

  = 28.86 $m.^2$

  Rebar = 37.882L + 34.152

  = (37.882 x 22.72) +34.302

  = 895 kg.

- ***Pile length = 25.80 m. no of pile = 8***

  Concrete = 0.16L

  = 0.16x25.80

  = 4.13 $m.^3$

  Formwork = 1.2L + 1.6

  = (1.2x25.80) + 1.6

  = 32.56 $m.^2$

  Rebar = 37.882 L + 34.152

  = (37.882 x 25.80) +34.426

  = 1,013 kg.

Total quantity of material for pile

Concrete = (16 x 3.01) + (316 x 3.64) + (8 x 4.13)

= 4,502.4 m^3

Formwork = (16 x 24.16) + (316 x 28.86) + (8 x 32.56)

= 9,766.8 $m.^2$

Rebar = (16 x 747) + (316 x 895) + (8 x 1,013)

= 302,876 kg.

Abutment

Height (H) = 0.83 m. , 2(P1, P16)

Used formula from table 11 to determine quantity of material for abutment

Concrete = 1.2 H + 29.92

Formwork = 2.4 H + 60.64

Rebar = 212.52 H + 2,847.9

Replace H= 0.83 m.

Concrete = 1.2H + 29.92

= (1.2x0.83) + 29.92 = 30.92 $m.^2$

Formwork = 2.4H + 60.64

= (2.4x0.83) + 60.64 = 62.63 $m.^2$

Rebar = 212.52 H + 2,847.9

= (212.52x0.83) + 2,847.9 = 3,025 kg

Total quantity of material for abutment (P1, P16)

Concrete = 61.84 m^3

Formwork = 125.26 $m.^2$

Rebar = 6,050 kg.

Pier (10 + 30)

P2 & P15 ; 2 piers

Height (H) = 0.50 m. , Pier span 10 + 30 m.

Used formula from table11 to determine quantity of material for pier (H < 3 m.)

Concrete ($m.^3$) = 1.57H + 63.15

Formwork ($m.^2$) = 6.28H + 75.35

Rebar (kg.) = 292.29H + 8,292

Replace H= 0.50

Concrete = 1.57H + 63.15

= (1.57x0.50) + 75.35 = 63.94 $m.^3$

Formwork = 6.28H + 75.35

= (6.28x0.50) + 75.35 =78.49 $m.^2$

Rebar = 292.29H + 8,292

= (292.29x0.50) + 8,292 = 8,439 kg.

∴Total quantity of material for pier (P2, P15)

Concrete = 2 x 63.94 = 127.88 m^3

Formwork = 2 x 78.49 = 156.98 $m.^2$

Rebar = 2 x 8,439 = 16,878 kg.

Pier (20 + 30)

P5 & P12 ; 2 piers

height (H) = 0.68 m. Pier span 20 + 30 m.

Used formula from table12 to determine quantity of material for pier (H < 3 m.)

Concrete ($m.^3$) = 1.57H + 63.15

Formwork ($m.^2$) = 6.28H + 75.35

Rebar (kg.) = 292.29H + 8,292

Replace H= 0.50 m. ;

Concrete = 1.57H + 63.15

= (1.57x0.68) + 63.15 = 64.22 $m.^3$

Formwork = 6.28H + 75.35

= (6.28x0.68) + 75.35 = 79.62 $m.^2$

Rebar = 292.29H + 6,320.1

= (292.29x0.68) + 6,320.1 = 6,489 kg.

∴Total quantity of material for pier (P5, P12)

Concrete = 2 x 64.22 = 128.44 m^3

Formwork = 2 x 79.62 = 159.24 $m.^2$

Rebar = 2 x 6,489 = 12,978 kg.

<u>Pier</u> (30 + 30)

P6, P7, P8, P9, P10, P11 ; 6 piers

height = 2.95 m. Pier span 30 + 30 m.

Used formular from table12 to determine quantity of material for pier (H < 3 m.)

Concrete = 1.57 H + 70.84

Formwork = 6.28 H + 71.22

Rebar = 292.29 H + 10,752

Replace H= 2.95 m. ;

Concrete = 1.57 H + 70.84

= (1.57 x 2.95) + 70.84 = 75.48 $m.^3$

Formwork = 6.28 H + 71.22

= (6.28 x 2.95) + 71.22 = 89.75 $m.^2$

Rebar = 292.29 H + 10,752

= (292.29 x 2.95) + 10,752 = 12,137 kg.

Total quantity of material for pier P6,P7,P8,P9,P10,P11

Concrete = 453 $m.^3$

Formwork = 539 $m.^2$

Rebar = 72,822 kg.

Pier (20 + 20)

P3, P4 & P13, P14 ; 4 piers

Height (H) = 0.90 m. Pier span 20 + 20 m.

Used formula from table12 to determine quantity of material for pier (H < 3 m.)

Concrete = 1.57H + 53.35

Formwork = 6.28H + 39.12

Rebar = 292.29H + 6,320.1

Replace H= 0.90 m. ;

Concrete = 1.57H + 53.35

= (1.57x0.90) + 53.35 = 54.76 $m.^3$

Formwork = 6.28H + 39.12

= (6.28x0.90) + 39.12 = 44.78 $m.^2$

Rebar = 292.29H + 6,320.1

= (292.29x0.90) + 6,320.1 = 6,544 kg.

Total quantity of material for pier P3, P4,P13, P14

Concrete = 4 x 54.76 = 219.04 m^3

Formwork = 4 x 44.78 = 179.12 $m.^2$

Rebar = 4 x 6,544 = 26,176 kg.

Total quantity of material concrete bridge

Concrete = 7,677.28 $m.^3$

Formwork = 23,555.00 $m.^2$

Rebar = 807,598 kg.

PC wire/strand = 58,312 kg.

Unit cost (materials cost and labor cost , year 2003)

concrete	= 2,100	baht/m^3
Formwork	= 214	baht/$m.^2$
Rebar	= 22	baht/kg.
PC wire/strand	= 44	baht/kg.

Total cost of concrete bridge

Concrete	= 16,774,857	baht
Formwork	= 5,040,770	baht
Rebar	= 17,969,056	baht
PC wire/strand	= 2,598,966	baht
Total	**= 42,383,649**	**baht**

From Appendix B4 the construction cost of project 28 at Narathiwat is 45,177,941 baht. This cost is divided into two main groups:

- cost of structure = 43,429,970 baht
- cost of miscellaneous = 1,747,971 baht

The results reveals that the percentage of structure costs and miscellaneous costs is 96.13 % and 3.83 % respectively. The CBS of these results is showed in Figure 5.

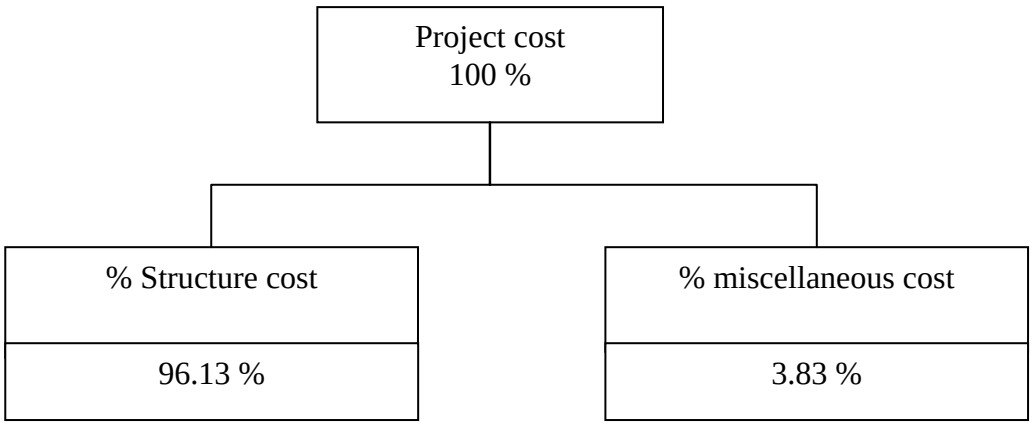

Figure 5 CBS for the cost of project 1.

Structures cost is comprised of:

- Super-structure cost (decks, sidewalks, rails) and;
- Sub-structure (pile, abutment and pier)

Miscellaneous cost consists of:

- Temporary-formwork structures
- Site office
- Plank-girder ,Box- girder and I-girder installation
- Painting work
- Earth work
- Approach slab
- Concrete slope protection
- Bridge signs
- Lighting systems
- Others

The researcher estimates the construction cost of a concrete bridge using tables and formulas. The result reveals that the cost estimate of project 1 is 42,383,649 baht and the error of project 1 is 2.40%

Project 2

Estimate quantity and cost of concrete bridge

Province: Nakhon Si Thammarat

Length of bridge	=	100.00 m.
Roadway	=	8.00 m.
Sidewalk	=	1.50 m.

Super – Structure

Type of deck

- Box – girder ; Five 20 meters length span

Sub – Structure

Pile

concrete pile size = 0.40 x 0.40 m.
length = 18.00 m. (56 piles)
length = 20.00 m. (44 piles)

Abutment ;

P1, P6 span 20 m., height = 0.75 m.

Pier

Pier span 20+20 m. = 2(P2,P5) ; height = 1.80 m.
Pier span 20+20 m. = 2(P3,P4) ; height = 3.225 m.

1. Determine the quantity of *super – structure* material

From table 7 quantity of super–structure material for *Box – girder deck*

Concrete = 7.03 $m.^3/m.$
Formwork = 48.37 $m.^2/m.$
Rebar = 753 kg./m.
PC wire / strand = 173 kg./m.

Quantity of super–structure material for *Box – girder deck*, five - 20 meters length span.

Concrete = 7.03 x 5 x 10
= 7.03 $m.^3$

Formwork = 48.37 x 5 x 20
= 4,837 $m.^2$

Rebar = 753 x 5 x 20
= 75,300 kg.

PC wire / strand = 173 x 5 x 20
= 17,300 kg.

Total quantity of material for super – structure

Concrete = 703 m.^{3}
Formwork = 4,837 m.^{3}
Rebar = 75,300 kg.
PC wire / strand = 17,300 kg.

2. Determine quantity of *sub – structure* material

pile

size = 0.40x0.40 m.
length = 18.00 m. (56 pile)
length = 20.00 m. (44 pile)

Used formula from table 10 to determine quantity of material for pile

$13.00 < L \leq 19.00$ m.; where L = pile length (m.)

Concrete (m.^{3}) = 0.16L
Formwork (m.^{2}) = 1.2L + 1.6
Rebar (kg.) = 37.882 L + 34.152

- ***Pile length (L) = 18.00 m. no of pile = 56***

Replace L = 18.00 m.
Concrete = 0.16L
= 0.16x18 = 2.88 m.^{3}

Formwork = 1.2L + 1.6
= (1.2x18) + 1.6 = 23.20 m.^{2}

Rebar = 37.882L + 34.152
= (37.882x18) +34.152 = 716 kg.

- ***Pile length(L) = 20.00 m. no of pile = 44***

Used formula from table 10 to determine quantity of material for pile

19.00 < L ≤ 25.00 m.; where L = pile length (m.)

Concrete ($m.^3$) = 0.16L

Formwork ($m.^2$) = 1.2L + 1.6

Rebar (kg.) = 37.882L + 34.302

Replace L = 20.00 m.

Concrete = 0.16L

= 0.16x20 = 3.20 $m.^3$

Formwork = 1.2L + 1.6

= (1.2x20) + 1.6 = 25.60 $m.^2$

Rebar = 37.882L + 34.302

= (37.882x20) +34.302 = 792 kg.

Total quantity of material for pile

Concrete = 302.08 $m.^3$

Formwork = 2,425.60 $m.^2$

Rebar = 74,944 kg.

Abutment ;

Height (H) = 0.75 m. , P1, P6 pier span 20

Used formula from table 11 to determine quantity of material for abutment

Concrete ($m.^3$) = 1.2H + 29.92

Formwork ($m.^2$) = 2.4H + 77.28

Rebar (kg.) = 238.15 H + 3,140

Replace H = 0.75 m.

Concrete = 1.2H + 29.92

= (1.2x0.75) + 29.92

= 30.82 $m.^3$

Formwork = 2.4H + 77.28
= (2.4x0.75) + 77.28
= 79.08 $m.^2$

Rebar = 238.15H + 3,140
= (238.15x0.75) + 3,140
= 3,319 kg.

Total quantity of material for abutment (P1, P6)

Concrete = 61.64 $m.^3$

Formwork = 158.61 $m.^2$

Rebar = 6,638 kg.

<u>Pier</u> (20 + 20)

P2& P5 ; 2 piers

Pier span 20 + 20 m. , height = 1.80 m.,

Used formula from table12 to determine quantity of material for pier (H < 3 m.)

Concrete = 1.57H + 53.35
Formwork = 6.28H + 39.12
Rebar = 248.12H + 6,320

Replace H = 1.80 m.

Concrete = 1.57H + 53.35
= (1.57x1.80) + 53.35
= 56.18 $m.^3$

Formwork = 6.281H + 39.12
= (6.28x1.80) + 39.12
= 50.43 $m.^2$

Rebar = 248.12H + 6,320
= (248.12x1.80) + 6,320.1
= 6,767 kg.

Total quantity of material for pier (P2,P5)

Concrete = 112.36 $m.^3$

Formwork = 100.86 $m.^2$

Rebar = 13,534 kg.

<u>Pier</u> (20 + 20)

P3& P4 ; 2 piers

Pier span 20 + 20 m. , height = 3.255 m.,

Used formula from table12 to determine quantity of material for pier (3 < H < 6 m.)

Concrete ($m.^3$) = $1.57H + 53.35$ $m.^3$

Formwork ($m.^2$) = $6.28H + 39.12$ $m.^2$

Rebar (kg.) = $380.84H + 7,073$ $m.^2$

Replace H = 3.255 m.

Concrete = $1.57 H + 53.35$

= $(1.57 \times 3.255) + 53.35$

= 58.46 $m.^3$

Formwork = $6.28H + 39.12$

= $(6.28 \times 3.255) + 39.12$

= 59.5 $m.^2$

Rebar = $380.84H + 7,073$

= $(380.84 \times 3.255) + 7,073$

= 8,313 kg.

Total quantity of material for pier P3, P4

Concrete = 116.92 $m.^3$

Formwork = 119 $m.^2$

Rebar = 16,626 kg.

Total quantity of material for pier (P2, P3, P4, P5)

Concrete = 229.28 m.^{3}

Formwork = 219.26 m.^{2}

Rebar = 30,160 kg.

Total quantity of material concrete bridge

Concrete = 1,296 m.^{3}

Formwork = 7,640 m.^{2}

Rebar = 187,042 kg.

PC wire/strand = 17,300 kg.

Unit cost (materials cost and labor cost ,year 2003)

concrete	**=**	**2,250**	**baht/m^3**
Formwork	**=**	**215**	**baht/m.^{2}**
Rebar	**=**	**22**	**baht/kg.**
PC wire/strand	**=**	**45**	**baht/kg.**

Total cost of concrete bridge

Concrete	=	2,916,000 baht
Formwork	=	1,642,626 baht
Rebar	=	4,111,924 baht
PC wire/strand	=	778,500 baht
Total	**=**	**9,452,050 baht**

From Appendix B4 the construction cost of project 26 at Nakhon Si Thammarat is 11,633,697 baht. This cost is divided into two main groups:

- cost of structure = 9,721,289 baht
- cost of miscellaneous = 1,912,408 baht

The results reveals that the percentage of structure costs and miscellaneous costs is 83.56 % and 16.44 % respectively. The CBS of these results is showed in Figure 6.

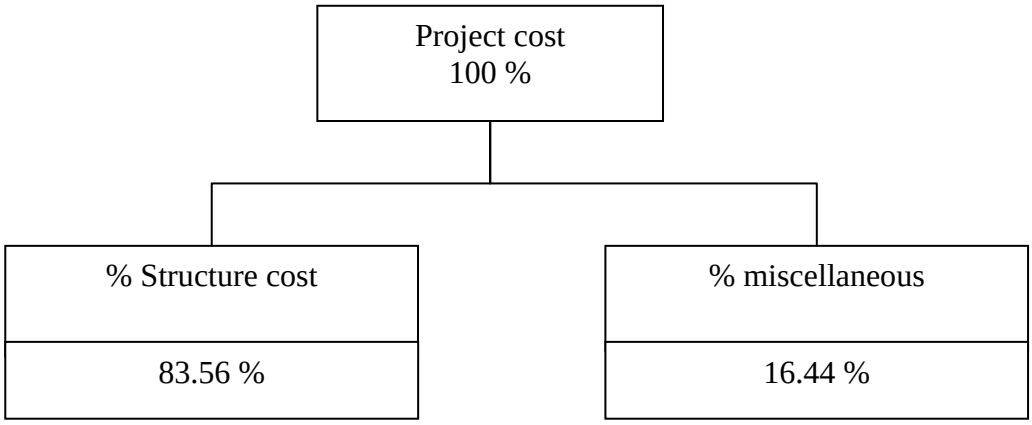

Figure 6 CBS for the cost of project 2.

Structures cost is comprised of:

- Super-structure cost (decks, sidewalks, rails) and;
- Sub-structure cost (pile, abutment and pier)

Miscellaneous cost consists of:

- Temporary-formwork structures
- Site office
- Box- girder installation
- Painting work
- Earth work
- Approach slab
- Concrete slope protection
- Bridge signs
- Lighting systems
- Others.

The researcher estimates the construction cost of a concrete bridge using invented tables and formulas. The result reveals that the cost 9,452,050 baht and the error of project 2 is 2.77 %

Project 3

Example Estimate of the quantity of concrete bridge material

Province : Lopburi
Length of bridge = 160.00 m
Roadway = 8.00 m
Sidewalk = 1.50 m

Super – Structure

Type of deck
- R.C slab; Four - 10 meters length span
- Box – girder; Six - 20 meters length span

Sub – Structure

Pile

Concrete pile size = 0.40 x 0.40 m.
Length = 10.00 m. (180 piles)

Abutment ;

Span 10 m. P1 and P11 , height = 2.75 m.

Pier

Pier span 10 + 10 m. = 2 (P2, P10) ;height = 3.88 m.
Pier span 10 + 20 m. = 2 (P3, P9) ;height = 3.52 m.
Pier span 20 + 20 m. = 3 (P4, P5, P8) ;height = 3.52 m.
Pier span 20 + 30 m. = 2 (P6, P7) ;height = 3.52 m.

1. Determine the quantity of *super – structure* material

From table 5 quantity of Super–structure material for R.C. slab deck

Concrete = 6.40 $m.^3/m.$
Formwork = 17.40 $m.^2/m.$

Rebar = 927.80 kg./m.

Quantity of super-structure material for R.C. slab deck , four - 10 meters length span

Concrete = 6.4x4x10
= 256 $m.^3$

Formwork = 17.4x4x10
= 696 $m.^2$

Rebar = 927.8x4x10
= 3,712 kg.

From table 7 quantity of super–structure material for *Box – girder deck*

Concrete = 7.03 $m.^3$/m.
Formwork = 48.37 $m.^2$/m.
Rebar = 753 kg./m.
PC wire / strand = 173 kg./m.

Quantity of super–structure material for *Box – girder deck*, six - 20 meters length span.

Concrete = 7.03 x 6 x 20
= 843.6 $m.^3$

Formwork = 48.37 x 6 x 20
= 5,804.4 $m.^2$

Rebar = 753 x 6 x 20
= 90,360 kg.

PC wire / strand = 173 x 6 x 20
= 20,760 kg.

Total quantity of material for super – structure

Concrete ***= 1,100 m.^{3}***

Formwork ***= 6,500 m.^{3}***

Rebar ***= 94,072 kg.***

PC wire / strand ***= 20,670 kg.***

2. Determine quantity of *sub – structure* material

<u>Pile</u>

size = 0.40 x 0.40 m.

Length = 10.00 m. , no. of pile = 180

Used formula from table 10 to determine quantity of material for pile

$7.00 < L \leq 13.00$ m.; where L = pile length (m.)

Concrete (m.^{3}) = 0.16L

Formwork (m.^{2}) = 1.2L + 1.6

Rebar (kg.) = 20.172L + 34

- ***Pile length (L) = 10.00 m. no of pile = 180***

Replace L = 10.00 m.

Concrete = 0.16L

= 0.16 x 10.00 = 1.6 m.^{3}

Formwork = 1.2L + 1.6

= (1.2x10.00) + 1.6 = 13.6 m.^{2}

Rebar = 20.172L + 34

= (20.172x10.00) +34 = 236 kg.

Total quantity of material for pile

Concrete = 288 m.^{3}

Formwork = 2,448 m.^{2}

Rebar = 42,480 kg.

Abutment ;

Height (H) = 2.75 m. , P1, P11 pier span 10 m.

Used formula from table 11 to determine quantity of material for abutment

Concrete (m.^{3}) = 1.2H + 29.92

Formwork (m.^{2}) = 2.4H + 60.64

Rebar (kg.) = 212.52H + 2,847.9

Replace H = 2.75 m.

Concrete = 1.2H + 29.92

= (1.2x2.75) + 29.92 = 33.32 m.^{3}

Formwork = 2.4H + 60.64

= (2.4x2.75) + 60.64 = 67.24 m.^{2}

Rebar = 212.52H + 2,847.9

= (212.52x2.75) + 2,847.9 = 3,433 kg.

Total quantity of material for abutment (P1, P11)

Concrete = 66.64 m.^{3}

Formwork = 134.48 m.^{2}

Rebar = 6,866 kg.

Pier (10 + 10)

P2 , P10 ; 2 piers

Pier span 10 + 10 m. ;height = 3.88 m.

Used formula from table12 to determine quantity of material for pier ($3 \leq H < 6$ m.)

Concrete = 1.01H + 41.59 $m.^3$

Formwork = 5.03H + 53.64 $m.^2$

Rebar = 180.41H + 4,100 kg.

Replace H = 3.88 m.

Concrete = 1.01H + 41.59

= (1.01x3.88) + 41.59

= 45.50 $m.^3$

Formwork = 5.03H + 53.64

= (5.03x3.88) + 53.64

= 73.16 $m.^2$

Rebar = 180.41H + 4,100

= (180.41x3.88) + 4,100

= 4,800 kg.

Total quantity of material for pier (P2, P10)

Concrete = 91 $m.^3$

Formwork = 146.32 $m.^2$

Rebar = 9,600 kg.

<u>Pier</u> (10 + 20)

P3, P9 ; 2 piers

Pier Span 10 + 20 m. ; Height = 3.52 m.,

Used formula from table12 to determine quantity of material for pier ($3 \leq H < 6$ m.)

Concrete ($m.^3$) = 1.57H + 54.36

Formwork ($m.^2$) = 6.28H + 76.31

Rebar (kg.) = 345.42H + 7,221

Replace H = 3.52 m.

Concrete = 1.57H + 54.36
= (1.57x3.52) + 54.36
= 59.89 $m.^3$

Formwork = 6.28H + 76.31
= (6.28x3.52) + 76.31
= 98.42 $m.^2$

Rebar = 345.42H + 7,221
= (345.42x3.52) + 7,221
= 8,437 kg.

Total quantity of material for pier (P3, P9)

Concrete = 119.78 $m.^3$

Formwork = 196.84 $m.^2$

Rebar = 16,874 kg.

<u>Pier</u> (20 + 20)

P4, P5, P8 ; 3 piers

Pier span 20 + 20 m.; height = 3.52 m.

Used formula from table12 to determine quantity of material for pier ($3 \leq H < 6$ m.)

Concrete ($m.^3$) = 1.57H + 53.35

Formwork ($m.^2$) = 6.28H + 39.12

Rebar (kg.) = 345.42H + 7,072.7

Replace H = 3.52 m.

Concrete = 1.57 H + 53.35
= (1.57 x 3.52) + 53.35
= 58.88 $m.^3$

Formwork = 6.28 H + 39.12
= (6.28 x 3.52) + 39.12
= 61.23 $m.^2$

Rebar = 380.84 H + 7,072.7
= (380.84 x 3.52) + 7,072.7
= 8,414 kg.

Total quantity of material for pier (P4, P5,P8)

Concrete = 176.64 $m.^3$

Formwork = 183.69 $m.^2$

Rebar = 25,242 kg.

<u>Pier</u> (20 + 30)

P6, P7 ; 2 piers

Pier span 20 + 30 m. ; height = 3.52 m.

Used formula from table12 to determine quantity of material for pier ($3 \leq H < 6$ m.)

Concrete ($m.^3$) = 1.57H + 63.15
Formwork ($m.^2$) = 6.28H + 75.35
Rebar (kg.) = 345.42H + 6,163.6

Replace H = 3.52 m.

Concrete = 1.57H + 63.15
= (1.57x3.52) + 63.15
= 68.68 $m.^3$

Formwork = 6.28H + 75.35
= (6.28x3.52) + 75.35
= 97.46 $m.^2$

Rebar = 354.2H + 6,163.6
= (354.2x3.52) + 6,163.6
= 7,411 kg.

Total quantity of material for pier (P6, P7)

Concrete = 137.36 m.^{3}

Formwork = 194.92 m.^{2}

Rebar = 14,822 kg.

Total quantity of material concrete bridge

Concrete	**=**	**1,980**	**m.^{3}**
Formwork	**=**	**9,805**	**m.^{2}**
Rebar	**=**	**209,956**	**kg.**
PC wire/strand	**=**	**20,670**	**kg.**

Unit cost (materials cost and labor cost ,year 2005)

concrete	**=**	**2,350**	**baht/m^3**
Formwork	**=**	**180**	**baht/m.^{2}**
Rebar	**=**	**26**	**baht/kg.**
PC wire/strand	**=**	**46**	**baht/kg.**

Total cost of concrete bridge

Concrete	=	4,672,800 baht
Formwork	=	1,961,000 baht
Rebar	=	5,458,586 baht
PC wire/strand	=	950,820 baht
Total	**=**	**13,043,676 baht**

From Appendix B4 the construction cost of project 40 at Lopburi is 16,289,235 baht. This cost is divided into two main groups:

- cost of structure = 13,715,635 baht
- cost of miscellaneous = 2,573,600 baht

The results reveals that the percentage of structure costs and miscellaneous costs is 84.20 % and 15.80 % respectively. The CBS of these results is showed in Figure 7.

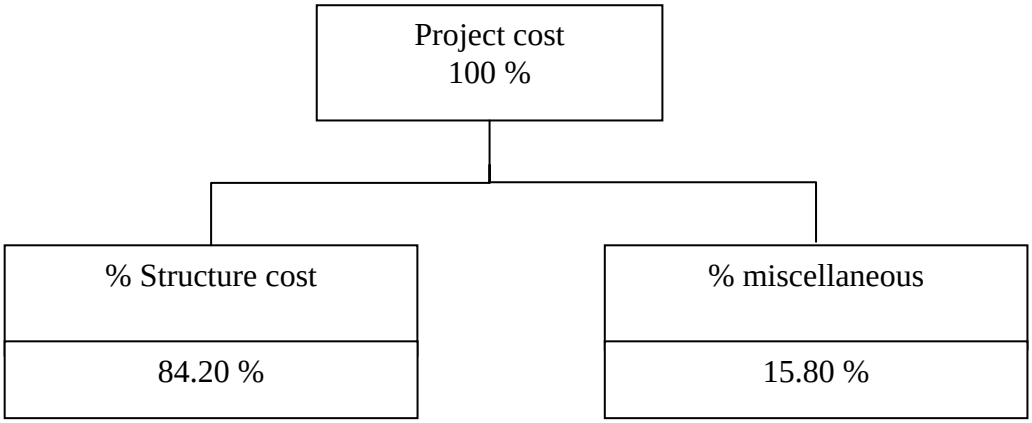

Figure 7 CBS for the cost of cost project 3.

Structures cost is comprised of :

- Super-structure cost (decks, sidewalks, rails) and;
- Sub-structure cost (pile, abutment and pier)

Miscellaneous cost consists of:

- Temporary-formwork structures
- Site office
- Box- girder installation
- Painting work
- Earth work
- Approach slab
- Concrete slope protection
- Bridge signs
- Lighting systems
- Others

The researcher estimates he construction cost of a concrete bridge using invented tables and formulas. The results that the cost estimate of project 3 is 13,043,476 baht and the error of project 3 is 4.90 %

Project 4

Example Estimate of the quantity of concrete bridge material

Province : Chiang Rai

Length of bridge	=	100.00 m
Roadway	=	8.00 m
Sidewalk	=	1.50 m

Super – Structure

Type of deck

- Plank – girder ; Four 10 meters length span
- Box – girder ; Three 20 meters length span

Sub – Structure

Pile

concrete pile ; size = 0.40 x 0.40 m.

length = 12.00 m. (120 piles)

Abutment

Span 10 m. ;P1, P8 ; height = 0.75 m.

Pier

Pier span 10+10 m.	P2,P7	;height = 1.45 m.
Pier span 10+20 m.	P3,P6	;height = 4.50 m.
Pier span 20+20 m.	P4,P5	;height = 5.00 m.

1. Determine the quantity of *super – structure* material

From table 6 quantity of super–structure material for plank-girder deck

Concrete	= 5.65	$m.^3/m.$
Formwork	= 24.45	$m.^2/m.$
Rebar	= 376	kg./m.
PC wire / strand	= 181	kg./m.

Quantity of Super–structure material for Plank – girder, four - 10 meters length span.

Concrete = 5.65x4x10
= 226 $m.^3$

Formwork = 24.45x4x10
= 978 $m.^2$

Rebar = 375.41x4x10
= 15,040 kg.

PC wire / strand = 181.08x4x 10
= 7,240 kg.

From table 7 quantity of super–structure material for *Box – girder deck*

Concrete	= 7.03	$m.^3/m.$
Formwork	= 48.37	$m.^2/m.$
Rebar	= 753	kg./m.
PC wire / strand	= 173	kg./m.

Quantity of super–structure material for *Box – girder deck*, three - 20 meters length span

Concrete = 7.03x3x20 $m.^3$
= 421.8 $m.^3$

Formwork = 48.37x3x20 $m.^2$
= 2,902.2 $m.^2$

Rebar = 753x3x20 kg.
= 45,180 kg.

PC wire / strand = 73x3x20 kg.
= 4,380 kg.

Total quantity of material for super – structure

Concrete = 648 $m.^3$
Formwork = 3,880 $m.^3$
Rebar = 60,220 kg.
PC wire / strand = 11,620 kg.

2. Determine quantity of *sub – structure* material

Pile

size = 0.40 x 0.40 m.
Length = 12.00 m. , no. of pile = 120

Used formula from table 10 to determine quantity of material for pile $7.00 < L \leq 13.00$ m.; where L = pile length (m.)

Concrete ($m.^3$) = 0.16L
Formwork ($m.^2$) = 1.2L + 1.6
Rebar (kg.) = 20.172L + 34.152

- ***Pile length (L) = 12.00 m. no of pile = 120***

Replace L = 12.00 m.
Concrete = 0.16L
= 0.16x12 = 1.92 $m.^3$

Formwork = 1.2L + 1.6
= 1.2x12 + 1.6 = 16 $m.^2$

Rebar = 37.882L + 34.152

= (37.882x12) +34.152 = 489 kg.

Total quantity of material for pile

Concrete = 231 m.^{3}

Formwork = 1,920 m.^{2}

Rebar = 58,680 kg.

Abutment

Height (H) = 1.03 m. , P1, P8 pier span 10

Used formula from table 11 to determine quantity of material for abutment

Concrete (m.^{3}) = 1.2H + 29.92

Formwork (m.^{2}) = 2.4H + 60.64

Rebar (kg.) = 212.52H + 2,847.9

Replace H = 1.03 m.

Concrete = 1.2H + 29.92

= (1.2x1.03) + 29.92

= 31.16 m.^{2}

Formwork = 2.4H + 60.64

= (2.4x1.03) + 60.64

= 63.11 m.^{2}

Rebar = 212.52H + 2,847.9

= (212.52x1.03) + 2,847.9

= 3,067 kg.

Total quantity of material for abutment (P1, P8)

Concrete = 63 m.^{3}

Formwork = 127 m.^{2}

Rebar = 6,134 kg.

Pier (10 + 10)

P2 & p7

Pier span 10 + 10 m. ,height = 1.45 m.

Used formula from table12 to determine quantity of material for pier (H < 3 m.).

Concrete = 1.01H + 41.59

Formwork = 5.03H + 53.64

Rebar = 128.02H + 4,100

Replace H = 1.45 m.

Concrete = 1.01H + 41.59

= (1.01x1.45) + 41.59

= 43.05 $m.^3$

Formwork = 5.03H + 53.64

= (5.03x1.45) + 53.64

= 60.93 $m.^2$

Rebar = 180.41H + 4,100

= (180.41x1.45) + 4,100

= 4,361.60 kg.

Total quantity of material for pier (P2, P7)

Concrete = 87 $m.^3$

Formwork = 122 $m.^2$

Rebar = 8,724 kg.

Pier (10 +20)

P3 & P6

Pier span 10 + 20 m. ,height = 2.36 m.

Used formula from table12 to determine quantity of material for pier (H < 3 m.).

Concrete ($m.^3$) = 1.57H + 54.36

Formwork ($m.^2$) = 6.28H + 76.31

Rebar(kg.) = 203.74H + 6,275

Replace H = 2.36 m.

Concrete = (1.57x2.36) + 54.36
= 58.07 $m.^3$

Formwork = (6.28x2.36) + 76.31
= 91.13 $m.^2$

Rebar = (203.74x2.36) + 6,275
= 6,756 kg.

Total quantity of material for pier (P3, P6)

Concrete = 117 $m.^3$

Formwork = 183 $m.^2$

Rebar = 13,512 kg.

Pier (20 + 20)

P4, P5, height = 3.28 m. , pier span 20 + 20

Pier span 20 + 20 m. ,height = 3.28 m.

Used formula from table12 to determine quantity of material for pier ($3 \leq H < 6$ m.)

Concrete ($m.^3$) = 1.57H + 53.35

Formwork ($m.^2$) = 6.28H + 39.12

Rebar (kg.) = 380.84H + 7,072.7

Replace H = 3.28 m.

Concrete = (1.57x3.28) + 53.35
= 58.50 $m.^3$

Formwork = (6.28x3.28) + 39.12
= 59.72 $m.^2$

Rebar = (380.84x3.28) + 7,072.7
= 8,322 kg.

Total quantity of material for pier (P4, P5)

Concrete ***= 117 m.^{3}***

Formwork ***= 120 m.^{2}***

Rebar ***= 16,644 kg.***

Total quantity of material concrete bridge

Concrete **= 1,263 m.^{3}**

Formwork **= 6,352 *m.^{2}***

PC wire/strand **= 11,620 kg.**

Unit cost (materials cost and labor cost ,year 2005)

concrete **= 2,380 baht/m^3**

Formwork **= 230 baht/m.^{2}**

Rebar **= 25 baht/kg.**

PC wire/strand **= 50 baht/kg.**

Total cost of concrete bridge

Concrete	=	3,005,940 baht
Formwork	=	1,460,960 baht
Rebar	=	4,097,850 baht
PC wire/strand	=	581,000 baht
Total	=	9,145,750 baht

From Appendix B4 the construction cost of project 52 at Chiang Rai is 11,507,470 baht. This cost is divided into two main groups:

- cost of structure = 9,384,200 baht
- cost of miscellaneous = 2,189,400 baht

The results reveals that the percentage of structure costs and miscellaneous costs is 81.55 % and 18.45 % respectively. The CBS of these results is showed in Figure 8.

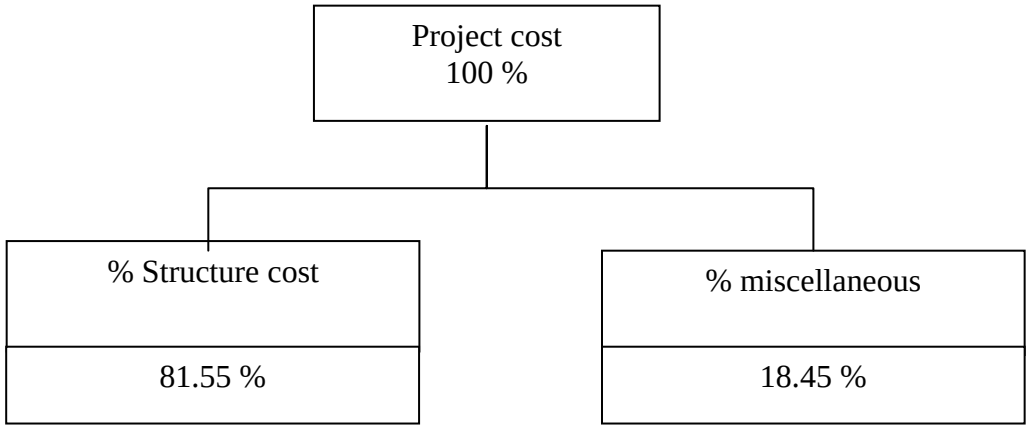

Figure 8 CBS for the cost of project 4.

Structures cost is comprised of:

- Super-structure cost (decks, sidewalks, rails) and;
- Sub-structure cost (pile, abutment and pier)

Miscellaneous cost consists of:

- Temporary-formwork structures
- Site office
- Plank-girder and Box- girder installation
- Painting work
- Earth work
- Approach slab
- Concrete slope protection
- Bridge signs
- Lighting systems
- Others

The researcher estimates the construction cost of a concrete bridge using invented tables and formulas. The result reveals that the cost estimate of project 4 is 9,145,750 baht and the error of project 4 is 2.54%

Project 5

Estimate quantity and cost of concrete bridge.

Province : Chiang Mai

Length of bridge	=	60.00 m.
Roadway	=	8.00 m.
Sidewalk	=	1.50 m.

Super – Structure

Type of deck

- Plank – girder ; Two 10 meters length span
- Box – girder ; Two 20 meters length span

Sub – Structure

Pile

concrete pile ; size = 0.40 x 0.40 m.

length = 7.00 m. (72 piles)

Abutment

span 20 m. P1 , P5 height = 1.74 m.

Pier

Pier span 10+20 m. = P2; height = 2.71 m.

Pier span 20+20 m. = P3; height = 3.31 m.

Pier span 10+20 m. = P4; height = 1.43 m.

1. Determine the quantity of *super – structure* material

From table 6 quantity of super–structure Material for plank-girder deck

Concrete = 5.65 $m.^3$/m.
Formwork = 24.45 $m.^2$/m.
Rebar = 375.41 kg./m.
PC wire / strand = 181.08 kg./m.

Quantity of Super–structure material for Plank – girder, two - 10 meters length span.

Concrete = 5.65 x 2 x 10
= 113 $m.^3$

Formwork = 24.45 x 2 x 10
= 488.4 $m.^2$

Rebar = 375.41 x 2 x 10
= 7,508 kg.

PC wire / strand = 181.08 x 2 x 10
= 3,622 kg.

From table 7 quantity of super–structure material for *Box – girder deck*

Concrete = 7.03 $m.^3$/m.
Formwork = 48.37 $m.^2$/m.
Rebar = 753 kg./m.
PC wire / strand = 173 kg./m.

Quantity of super–structure material for *Box – girder deck*, two - 20 meters length span

Concrete = 7.03x2x20 $m.^3$
= 218.20 $m.^3$

Formwork = 48.37x2x20 $m.^2$
= 1,934.8 $m.^2$

Rebar = 753x2x20 kg.
= 30,120 kg.

PC wire / strand = 173x2x20 kg.
= 6,920 kg.

Total quantity of material for super – structure

Concrete = 331.2 $m.^3$
Formwork = 2,423.2 $m.^3$
Rebar = 37,628 kg.
PC wire / strand = 10,542 kg.

2. Determine quantity of *sub – structure* material

Pile

size = 0.40 x 0.40 m.
Length = 7.00 m. , no. of pile = 72

Used formula from table 10 to determine quantity of material for pile

$7.00 < L \leq 13.00$ m. ; where L = pile length (m.)

Concrete ($m.^3$) = 0.16L
Formwork ($m.^2$) = 1.2L + 1.6
Rebar (kg.) = 20.172L + 34

- ***Pile length (L) = 7.00 m. no of pile = 72***

Replace L = 7.00 m.

Concrete = 0.16 L
= 0.16 x 7 = 1.12 $m.^3$

Formwork = 1.2 L
= 1.2x7 + 1.6 = 10 $m.^2$

Rebar = 20.172 L + 34

= (20.172x7) +34 = 176 kg.

Total quantity of material for pile

Concrete = 80.64 m.^{3}

Formwork = 720 m.^{3}

Rebar = 12,672 kg.

Abutment;

Height (H) = 1.74 m. 2(P1, P5) pier span 10 m.

Used formula from table 11 to determine quantity of material for abutment

Concrete (m.^{3}) = 1.2 H + 29.92

Formwork (m.^{2}) = 2.4 H + 60.64

Rebar (kg.) = 212.52 H + 2,847.9

Replace H = 1.74 m.

Concrete = 1.2 H + 29.92

= (1.2 x 1.74) + 29.92

= 32.008 m.^{2}

Formwork = 2.4 H + 60.64

= (2.4 x 1.74) + 60.64

= 64.816 m.^{2}

Rebar = 212.52 H + 2,847.9

= (212.52 x 1.74) + 2,847.9

= 3,218 kg.

Total quantity of material for abutment

Concrete = 64 m.^{3}

Formwork = 129.63 m.^{3}

Rebar = 6,436 kg.

Pier (10 + 20)

P2 ,height = 2.71 m. pier span 10 + 20 m.

Used formula from table12 to determine quantity of material for pier (H < 3 m.)

Concrete ($m.^3$) = 1.57 H + 54.36

Formwork ($m.^2$) = 6.28H + 76.31

Rebar (kg.) = 203.74H + 6,275

Replace H = 2.71 m.

Concrete = 1.57 H + 54.36

= (1.57 x 2.71) + 54.36

= 58.61 $m.^3$

Formwork = 6.28 H + 76.31

= (6.28 x 2.71) + 76.31

= 93.32 $m.^2$

Rebar = 203.74 H + 6,275

= (203.74 x 2.71) + 6,275

= 6,828 kg.

Pier (20 + 20)

P3 ,height = 3.31 m. pier span 20 + 20 m.

Used formula from table12 to determine quantity of material for pier ($3 \leq H < 6$ m.)

Concrete ($m.^3$) = 1.57 H + 53.35

Formwork ($m.^2$) = 6.28H + 39.12

Rebar (kg.) = 380.84H + 7072.7

Replace H = 3.31 m.

Concrete = (1.57x3.31) + 53.35

= 58.55 $m.^3$

Formwork = (6.28x3.31) + 39.12
= 59.91 $m.^2$

Rebar = (203.74x3.31) + 7,072.7
= 8,334 kg.

<u>Pier</u> (10 + 20)

P4 ,height = 1.43 m. pier span 10 + 20 m.

Used formula from table12 to determine quantity of material for pier (H < 3 m.)

Concrete ($m.^3$) = 1.57 H + 54.36
Formwork ($m.^2$) = 6.28H + 76.31
Rebar (kg.) = 203.74H + 6,275

Replace H = 1.43 m.

Concrete = (1.57 x 1.43) + 54.36
= 56.61 $m.^3$

Formwork = (6.28 x 1.43) + 76.31
= 85.29 $m.^2$

Rebar = (203.74 x 1.43) + 6,275
= 6,567 kg.

Total quantity of material for pier (P2, P3, P4)

Concrete = 173.8 $m.^3$
Formwork = 238.52 $m.^2$
Rebar = 21,729 kg.

Total quantity of material concrete bridge

Concrete = 650 $m.^3$
Formwork = 3,512 $m.^2$
Rebar = 78,465 kg.
PC wire/strand = 10,542 kg.

Unit cost (materials cost and labor cost , year 2005)

concrete	**= 2,380**	**baht/m^3**
Formwork	**= 298**	**baht/$m.^2$**
Rebar	**= 22**	**baht/kg.**
PC wire/strand	**= 45**	**baht/kg.**

Total cost of concrete bridge

Concrete	=	1,547,000 baht
Formwork	=	1,046,576 baht
Rebar	=	1,726,230 baht
PC wire/strand	=	474,390 baht
Total	**=**	**4,794,196 baht**

From Appendix B4 the construction cost of project 49 at Chiang Mai is 6,670,470 baht. This cost is divided into two main groups:

- cost of structure = 5,092,700 baht
- cost of miscellaneous = 1,577,770 baht

The results reveals that the percentage of structure costs and miscellaneous costs is 76.34 % and 23.66 % respectively. The CBS of these results is showed in Figure 9.

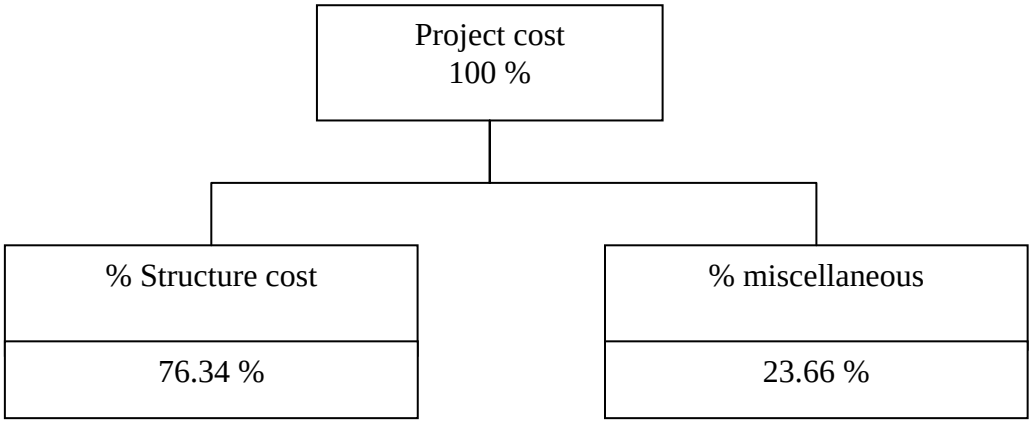

Figure 9 CBS for the cost of project 5.

Structures cost comprise of:

- Super-structure cost (decks, sidewalks, rails) and;
- Sub-structure (pile, abutment and pier)

Miscellaneous cost consists of:

- Temporary-formwork structures
- Site office
- Plank-girder and Box- girder installation
- Painting work
- Earth work
- Approach slab
- Concrete slope protection
- Bridge signs
- Lighting systems
- Others

The researcher estimates the construction cost of a concrete bridge using invented tables and formulas. The result reveals that the cost estimate of project 5 is 4,794,196 baht and the error of project 5 is 5.86%

Changes in the cost of bridge construction projects in each year.

The researcher changes the costs of concrete bridges each year using an index based on the year 2001 cost data. The index is the inverse of the escalation factor (K-factor).

According to Table 13,the average cost per length of concrete bridges is *83,359, 92,141, 97,576, and 113,006* in the year of 2001 to 2004 respectively.

Table 13 Average cost per length of concrete-bridge construction projects between 2001 and 2004

Year	Average Cost/Length (Baht/Metre)
2001	83,359.27
2002	92,141.49
2003	97,576.91
2004	113,006.82

Computation of Escalation (K)

Reinforced Concrete Structures, Pile, Bearing

Used formula $K = 0.30 + 0.10\frac{It}{Io} + 0.15\frac{Ct}{Co} + 0.20\frac{Mt}{Mo} + 0.25\frac{St}{So}$

Where

I = General consumer price index of Thailand
C = Cement price index
M = Construction materials (Exclude cement & Steel)
S = Steel piece index
T = Date of tender
O = Date of opening bidded
F_{CA} = Cost adjustment factor

Calculation cost adjustment factor (F_{CA}) 2002:2001

From table c-1 January 2001: $I_o = 181.4$,$C_o = 190.0$,$M_o = 193.8$,$S_o = 119.2$

From table c-2 January 2002: $I_t = 182.7$, $C_t = 140.1$,$M_t = 196.4$, $S_t = 129.3$

$$K = 0.30 + 0.10\frac{It}{Io} + 0.15\frac{Ct}{Co} + 0.20\frac{Mt}{Mo} + 0.25\frac{St}{So}$$

$$= 0.30 + 0.10 \times \left(\frac{182.7}{181.4}\right) + 0.15\left(\frac{140.1}{190.0}\right) + 0.20\left(\frac{196.4}{193.8}\right) + 0.25\left(\frac{129.3}{119.2}\right)$$

$$= 0.30 + 0.10 \times (1.007) + 0.15\ (0.737) + 0.20\ (1.013) + 0.25\ (1.084)$$

$$= 0.30 + 0.100 + 0.110 + 0.202 + 0.271$$

$$= 0.983$$

Cost adjustment factor (F_{CA}) = 1/K = 1/0.983 = 1.017

$P_{2001} = P_{2002}$ x Cost adjustment factor (F_{CA})

Calculation cost adjustment factor (F_{CA}) 2003:2001

From table c-3 January 2003 ;$I_t = 186.8$, $C_t = 194.4$,$M_t = 202.0$,$S_t = 149.0$

From table c-1 January 2001 ;$I_o = 181.4$,$C_o = 194.0$,$M_o = 193.8$,$S_o = 119.2$

$$K = 0.30 + 0.10\frac{It}{Io} + 0.15\frac{Ct}{Co} + 0.20\frac{Mt}{Mo} + 0.25\frac{St}{So}$$

$$= 0.30 + 0.10 \times \left(\frac{186.8}{181.4}\right) + 0.15\left(\frac{194.4}{190.0}\right) + 0.20\left(\frac{202.0}{193.8}\right) + 0.25\left(\frac{149.0}{119.2}\right)$$

$$= 0.30 + 0.10 \times (1.029) + 0.15\ (0.023) + 0.20\ (1.042) + 0.25\ (1.25)$$

= 0.30 + 0.102 + 0.153 + 0.208 + 0.312

= 1.075

Cost adjustment factor (F_{CA}) = 1/K = 1/1.075 = 0.930

P_{2001} = P_{2003} x Cost adjustment factor (F_{CA})

Calculation cost adjustment factor (F_{CA}) 2004:2001

From table c-4 January 2004 ; $I_t = 189.1$,$C_t = 195.3$, $M_t = 212.5$, $S_t = 208.8$

From table c-1 January 2001 ; $I_o = 181.4$, $C_o = 190.0$, $M_o = 193.8$, $S_o = 119.2$

$$K = 0.30 + 0.10\frac{It}{Io} + 0.15\frac{Ct}{Co} + 0.20\frac{Mt}{Mo} + 0.25\frac{St}{So}$$

$$= 0.30 + 0.10 \times \left(\frac{189.1}{181.4}\right) + 0.15\left(\frac{195.3}{190.0}\right) + 0.20\left(\frac{212.5}{193.8}\right) + 0.25\left(\frac{208.8}{119.2}\right)$$

$$= 0.30 + 0.10 \times (1.042) + 0.15\,(1.027) + 0.20\,(1.096) + 0.25\,(1.751)$$

$$= 0.30 + 0.104 + 0.154 + 0.219 + 0.437$$

$$= 1.214$$

cost adjustment factor (F_{CA}) = 1/K = 1/1.214 = 0.823

$P_{2001} = P_{2004}$ x Cost adjustment factor (F_{CA})

Table 14 shows the K-factors and indexes for the year 2002 to 2004 based on the year 2001. The obtained K-factors are the reverse of the indexes; therefore, the indexes are computed. The K-factors for the year 2002 to 2004 are 0.983, 1.075, and 1.214, respectively. The cost adjustment factor (F_{CA}) for the year 2002 to 2004 are 1.017, 0.930, and 0.832, respectively.

Table 14 K-factors and cost adjustment factor (F_{CA}) for the year 2002 to 2004 based on the year 2001.

Year	K	cost adjustment factor (F_{CA}) (1/K)
2001:2002	0.983	1.017
2001:2003	1.075	0.930
2001:2004	1.214	0.823

Using the represented indexes, Table 15 shows that the adjusted cost per length is 83,300, 93,707, 90,747, and 92,990 for the year 2001 to 2004 respectively.

Table 15 The computed cost/length (Baht/m.) for the year 2001 to 2004.

Year	Cost/length (Baht/m.)	cost adjustment factor (F_{CA}) (1/K)	Cost/length x cost adjustment factor (F_{CA}) (Baht/m.)
2001	83,300	1.000	83,300
2002	92,141	1.017	93,707
2003	97,576	0.930	90,747
2004	113,000	0.823	92,900

Note: Width = 11.00 m.

DISCUSSION

Advantages and limitations of this research study are made below, respectively. The limitations mostly come from a limited number of data collected, a period of time used and environmental effects. However, some suggestions are introduced for better use of the research results.

Advantages

1. This study presents the percentage of cost components of concrete-bridge construction projects. The generated CBS can be used to ensure the cost estimates and compare cost components of a bridge project to the averaged values shown in the CBS.

2. The established tables and formula can be used to determine the quantity of materials of concrete bridges. This significantly helps an estimator to faster calculate the number, which makes the computation better and easier.

3. The developed indexes can help forecast costs of concrete bridges.

Limitations and suggestions

1. The presented CBS can be used for different types and sizes of the bridges. However, there is a variation due to the location of the project and the distance from the available resources and the site. Also, the price of the materials has changed over time, especially in recent years. As a result, the CBS might cause some errors.

2. The gathered data for this research study do not include the costs of special items such as concrete slope protection, approach slabs, bearing units, site offices, lighting systems and embankment. Using the presented graphs and tables to estimate the quantity of concrete-bridge materials can cause an inaccuracy in the resulting numbers. Therefore, in case of an existance of special items, costs of these items must be additionally included.

3. The established cost adjustment factor (F_{CA}) are computed from the reversed K-factor which does not involve temporary formwork structures and painting. As a result, to determine the costs of concrete structures with temporary-formwork structures and painting work, some errors may rise.

CONCLUSION

This chapter refers to the conclusion of this research study showing what have been achieved based on the research objectives. It contains not only some examples of how to use the generated equations and models, but also discussions of the advantages and limitations of the study, ending with some suggestions about what should be done to make the results more accurate.

According to the research results, the objectives of the study were achieved as explained below.

1. The first objective is to explore cost components of concrete-bridge construction projects. The cost components were developed in the form of the cost breakdown structure (CBS). The generated CBS is shown below.

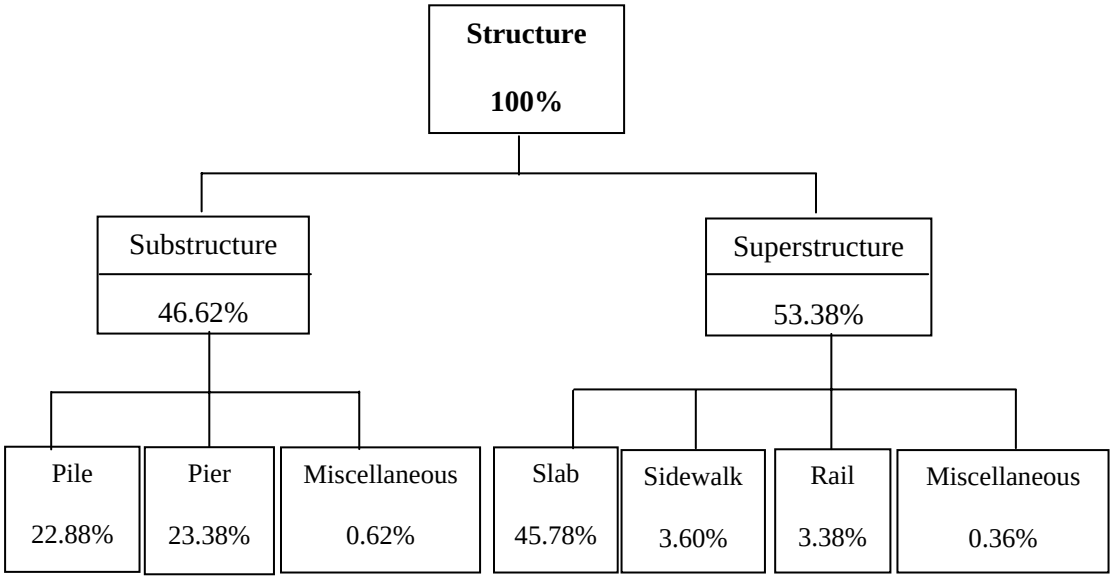

Figure 11 Cost Breakdown Structure (CBS)

2. To establish tables and formula to display the quantity of materials used for different types of concrete bridges.

At this stage, models for calculating construction costs and the quantity of materials for bridge construction projects were tested and checked for error.This was done by using the models to calculate the construction cost of five bridge construction projects. The result revealed some errors in construction costs estimate. These errors are shown below:

- Error of project 1 = 2.40%
- Error of project 2 = 2.77%
- Error of project 3 = 4.90%
- Error of project 4 = 2.54%
- Error of project 5 = 5.86%

From the results above, it can be said that tables and formulas invented can be utilized to estimate construction costs as the percentage of error is negligible.

3. To determine cost adjustment factor (F_{CA}) used to measure changes in the costs of bridge construction projects in each year, using the escalation factor (K-factor).

Cost adjustment factor (F_{CA}) factors for the year 2002 to 2004 are 0.983, 1.075, and 1.214, respectively. The indexes for the year 2002 to 2004 are 1.017, 0.930, and 0.832, respectively.

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APPENDICES

APPENDIX A

Appendix Table A1 Construction cost of concrete bridge 2001

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
1	Trang	100.00	June	3,345,100.00	2,974,540.00	6,319,640.00	63,196.40
2	Trang	120.00	June	3,898,542.00	3,791,109.00	7,689,651.00	64,080.43
3	Chaing Mai	180.00	May	6,722,709.00	5,183,801.00	11,906,510.00	66,147.28
4	Kamphaeng Phet	420.00	June	21,529,000.00	16,544,440.00	38,073,440.00	90,651.05
5	Kalasin	120.00	May	5,365,329.00	5,544,471.00	10,909,800.00	90,915.00
6	Kanchanaburi	260.00	April	11,099,969.00	7,621,375.00	18,721,344.00	72,005.17
7	Chumphon	180.00	May	6,598,813.00	4,617,286.17	11,216,099.17	62,311.66
8	Roi Et	100.00	May	3,458,499.00	4,077,392.00	7,535,891.00	75,358.91
9	Maha Sarakham	140.00	June	4,545,486.00	4,287,530.00	8,833,016.00	63,092.97
10	Phetchabun	80.00	August	4,516,455.00	3,409,448.00	7,925,903.00	99,073.79
11	Lamphun	200.00	May	8,269,267.00	9,400,332.00	17,669,599.00	88,348.00
12	Lampang	150.00	April	7,268,006.00	4,674,174.56	11,942,180.56	79,614.54
13	Si Sa Ket	100.00	May	3,703,022.00	2,929,325.00	6,632,347.00	66,323.47

Appendix Table A1 (cont'd)

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
14	Songkhla	60.00	June	3,295,926.00	2,607,704.00	5,903,630.00	98,393.83
15	Songkhla	100.00	July	3,051,048.00	3,133,150.00	6,184,198.00	61,841.98
16	Sing Buri	265.00	July	10,699,642.00	10,079,913.00	20,779,555.00	78,413.42
17	Satun	290.00	June	12,628,368.00	10,398,930.00	23,027,298.00	79,404.48
18	Sakon Nakhon	120.00	June	4,110,430.00	2,899,132.00	7,009,562.00	58,413.02
19	Phichit	180.00	March	7,086,237.00	6,650,882.00	13,737,119.00	76,317.33
20	Phra Nakhon Si Ayutthaya	120.00	September	4,846,668.00	3,513, 681.00	8,360,349.00	69,669.58
21	Phuket	90.00	June	5,801,584.00	7,496,864.00	13,298,448.00	147,760.53
22	Patthalung	140.00	June	5,137,835.00	5,197,780.00	10,335,615.00	73,825.82
23	Phetchaburi	130.00	June	5,330,650.00	5,088,850.00	10,419,500.00	80,150.00
24	Pattani	120.00	May	4,927,517.00	3,719,273.00	8,646,790.00	72,056.58
25	Narathiwat	80.00	June	4,927,243.00	4,473,076.00	9,400,319.00	117,503.99
26	Nakhon Sawan	410.00	June	16,695,910.00	16,605,090.00	33,301,000.00	81,221.95

Appendix Table A1 (cont'd)

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
27	Suphan Buri	254.40	June	12,456,318.00	11,036,158.00	23,492,476.00	92,344.64
28	Uttaradit	100.00	August	5,801,040.00	4,416,120.00	10,217,160.00	102,171.60
29	Amnat Charoen	100.00	May	4,590,900.00	4,081,840.00	8,672,740.00	86,727.40
30	Ang Thong	60.00	September	2,766,215.00	4,276,083.00	7,042,298.00	117,371.63
31	Surat Thani	120.00	May	5,591,488.00	5,080,689.00	10,672,177.00	88,934.81
32	Surat Thani	200.00	June	10,044,663.00	5,600,985.00	15,645,648.00	78,228.24
33	Phra Nakhon Si Ayutthaya	60.00	June	3,174,189.29	3,364,988.41	6,539,177.70	108,986.30
	AVERAGE						**83,359.27**

Appendix Table A2 Construction cost of concrete bridge 2001 (super - structure)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
1	100.00	-	2,876,525.00	-	-	222,400.00	193,798.00	52,377.00	3,345,100.00
2	120.00	-	3,372,480.00	-	-	260,160.00	230,574.00	35,328.00	3,898,542.00
3	180.00	426,800.00	-	5,426,080.00	-	426,960.00	384,541.00	58,328.00	6,722,709.00
4	420.00	-	-	18,930,870.00	-	1,260,000.00	1247250.00	90,880.00	21,529,000.00
5	120.00	688,750.00	3,870,030.00	-	-	417,840.00	347,208.00	41,501.00	5,365,329.00
6	260.00	-	-	9,914,190.00	-	826,280.00	324,198.00	35,301.00	11,099,969.00
7	180.00	-	-	5,689,188.00	-	475,920.00	391,124.00	42,581.00	6,598,813.00
8	100.00	-	2,995,370.00	-	-	255,400.00	189,735.00	17,994.00	3,458,499.00
9	140.00	-	3,920,700.00	-	-	330,120.00	240,366.00	54,300.00	4,545,486.00
10	80.00	-	-	3,919,689.00	-	277,135.00	243,359.00	76,272.00	4,516,455.00
11	200.00	1,378,980.00	-	5,579,721.00	-	692,000.00	564,348.00	54,218.00	8,269,267.00
12	150.00	885,420.00	-	5,484,600.00	-	435,680.00	399,648.00	62,658.00	7,268,006.00
13	100.00	-	3,220,500.00	-	-	271,200.00	178,059.00	33,263.00	3,703,022.00
14	60.00	-	-	2,892,390.00	-	187,080.00	149,767.00	66,689.00	3,295,926.00
15	100.00	1,201,020.00	-	1,413,000.00	-	202,000.00	189,968.00	45,060.00	3,051,048.00
16	265.00	779,500.00	8,796,574.00	-	-	552,260.00	518,992.00	52,316.00	10,699,642.00

Appendix Table A2 (cont'd)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
17	290.00	-	11,175,475.00	-	-	741,240.00	646,938.00	64,715.00	12,628,368.00
18	120.00	-	3,510,000.00	-	-	288,000.00	254,650.00	57,780.00	4,110,430.00
19	180.00	-	-	5,901,120.00	-	575,280.00	534,280.00	75,557.00	7,086,237.00
20	120.00	-	-	4,172,340.00	-	323,040.00	290,764.00	60,524.00	4,846,668.00
21	90.00	583,860.00	3,162,888.00	-	-	1,589,580.00	380,520.00	84,736.00	5,801,584.00
22	140.00	436,000.00	-	4,028,340.00	-	328,160.00	289,962.00	55,373.00	5,137,835.00
23	130.00	4,614,250.00	-	-	-	457,000.00	244,400.00	15,000.00	5,330,650.00
24	120.00	816,080.00	-	3,499,730.00	-	304,800.00	254,760.00	52,147.00	4,927,517.00
25	80.00	-	-	3,956,520.00	-	480,000.00	416,000.00	74,723.00	4,927,243.00
26	410.00	3,279,980.00	11,359,920.00	-	-	1,079,940.00	930,198.00	45,872.00	16,695,910.00
27	254.40	-	10,724,705.00	-	-	921,290.00	751,966.00	58,357.00	12,456,318.00
28	100.00	-	-	5,160,000.00	-	288,000.00	275,040.00	78,000.00	5,801,040.00
29	100.00	-	3,910,590.00	-	-	350,000.00	291,900.00	38,410.00	4,590,900.00
30	60.00	1,523,800.00	-	852,200.00	-	169,080.00	155,654.00	65,481.00	2,766,215.00
31	120.00	967,660.00	-	3,844,250.00	-	377,280.00	335,125.00	67,173.00	5,591,488.00

Appendix Table A2 (cont'd)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
32	200.00	-	5,733,760.00	3,058,360.00	-	675,200.00	528,660.00	48,683.00	10,044,663.00
33	60.00	641,893.11	-	2,045,698.24	-	224,720.90	193,737.91	68,139.14	3,174,189.30

Appendix Table A3 Construction cost of concrete bridge 2001 (sub - structure)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
1	Trang	100.00	11.00	1,435,320.00	1,507,720.00	52,377.00	2,995,417.00
2	Trang	120.00	11.00	1,841,152.00	1,897,315.00	35,328.00	3,773,795.00
3	Chaing Mai	180.00	11.00	2,302,944.00	2,846,313.00	58,328.00	5,207,585.00
4	Kamphaeng Phet	420.00	11.00	9,451,520.00	7,038,550.00	90,880.00	16,580,950.00
5	Kalasin	120.00	11.00	2,683,924.00	2,833,312.00	41,501.00	5,558,737.00
6	Kanchanaburi	260.00	11.00	4,627,444.00	2,976,016.00	35,301.00	7,638,761.00
7	Chumphon	180.00	11.00	1,901,372.00	2,698,622.00	42,581.00	4,642,575.00
8	Roi Et	100.00	11.00	2,067,456.00	1,982,066.00	17,994.00	4,067,516.00
9	Maha Sarakham	140.00	11.00	1,717,348.00	2,538,182.00	54,300.00	4,309,830.00
10	Phetchabun	80.00	11.00	1,894,036.00	1,461,730.00	76,272.00	3,432,038.00
11	Lamphun	200.00	11.00	6,087,516.00	3,283,217.00	54,218.00	9,424,951.00
12	Lampang	150.00	11.00	1,734,643.56	2,903,787.00	62,658.00	4,701,088.56
13	Si Sa Ket	100.00	11.00	1,183,000.00	1,725,925.00	33,263.00	2,942,188.00
14	Songkhla	60.00	11.00	1,425,424.00	1,152,010.00	66,689.00	2,644,123.00
15	Songkhla	100.00	11.00	1,901,150.00	1,192,000.00	45,060.00	3,138,210.00

Appendix Table A3 (cont'd)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
16	Sing Buri	265.00	11.00	5,764,452.00	4,228,805.00	52,316.00	10,045,573.00
17	Satun	290.00	11.00	6,450,700.00	3,896,280.00	64,715.00	10,411,695.00
18	Sakon Nakhon	120.00	11.00	736,282.00	2,122,810.00	57,780.00	2,916,872.00
19	Phichit	180.00	11.00	3,690,120.00	2,921,259.00	75,557.00	6,686,936.00
20	Phra Nakhon Si Ayutthaya	120.00	11.00	1,618,944.00	1,858,107.00	60,524.00	3,537,575.00
21	Phuket	90.00	11.00	1,320,176.00	6,168,988.00	84,736.00	7,573,900.00
22	Patthalung	140.00	11.00	2,885,112.00	2,282,058.00	55,373.00	5,222,543.00
23	Phetchaburi	130.00	11.00	4,330,250.00	742,800.00	15,000.00	5,088,050.00
24	Pattani	120.00	11.00	2,085,424.00	1,602,058.00	52,147.00	3,739,629.00
25	Narathiwat	80.00	11.00	3,159,396.00	1,290,400.00	74,723.00	4,524,519.00
26	Nakhon Sawan	410.00	11.00	6,954,090.00	9,610,000.00	45,872.00	16,609,962.00
27	Suphan Buri	254.40	11.00	6,332,688.00	4,680,510.00	58,357.00	11,071,555.00
28	Uttaradit	100.00	11.00	2,587,200.00	1,818,000.00	78,000.00	4,483,200.00
29	Amnat Charoen	100.00	11.00	2,189,600.00	1,870,000.00	38,410.00	4,098,010.00

Appendix Table A3 (cont'd)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
30	Ang Thong	60.00	11.00	2,588,696.00	1,678,241.00	65,481.00	4,332,418.00
31	Surat Thani	120.00	11.00	2,326,648.00	2,697,366.00	67,173.00	5,091,187.00
32	Surat Thani	200.00	11.00	2,690,640.00	2,870,350.00	48,683.00	5,609,673.00
33	Phra Nakhon Si Ayutthaya	60.00	11.00	2,071,218.88	1,250,329.10	68,139.14	3,389,687.12

Appendix Table A4 Project characteristic concrete bridge 2001

No.	Province	project characteristic							
		Length (m.)	Width (m.)	sidewalk (m.)	No. of span	R.C.Slab (mxl)	I-Girder (mxl)	box-Girder (mxl)	plank-girder (mxl)
1	Trang	100.00	11.00	1.50	5	-	5x20	-	-
2	Trang	120.00	11.00	1.50	6	-	6x20	-	-
3	Chaing Mai	180.00	11.00	1.50	10	2x10	-	8x20	-
4	Kamphaeng Phet	420.00	11.00	1.50	21	-	-	21x20	-
5	Kalasin	120.00	11.00	1.50	6	1x10	5x20	-	-
6	Kanchanaburi	260.00	11.00	1.50	13	-	-	13x20	-
7	Chumphon	180.00	11.00	1.50	9	-	-	9x20	-
8	Roi Et	100.00	11.00	1.50	5	-	5x20	-	-
9	Maha Sarakham	140.00	11.00	1.50	7	-	7x20	-	-
10	Phetchabun	80.00	11.00	1.50	4	-	-	4x20	-
11	Lamphun	200.00	11.00	1.50	13	6x10	-	7x20	-
12	Lampang	150.00	11.00	1.50	9	3x10	-	6x20	-
13	Si Sa Ket	100.00	11.00	1.50	5	-	5x20	-	-

Appendix Table A4 (cont'd)

No.	Province	project characteristic							
		Length (m.)	Width (m.)	sidewalk (m.)	No. of span	R.C.Slab (mxl)	I-Girder (mxl)	box-Girder (mxl)	plank-girder (mxl)
14	Songkhla	60.00	11.00	1.50	3	-	-	3x20	-
15	Songkhla	100.00	11.00	1.50	8	6x10	-	2x20	-
16	Sing Buri	265.00	11.00	1.50	9	4x10	5x25	-	-
17	Satun	290.00	11.00	1.50	11	4x20	7x30	-	-
18	Sakon Nakhon	120.00	11.00	1.50	6	-	6x20	-	-
19	Phichit	180.00	11.00	1.50	9	-	-	9x20	-
20	Phra Nakhon Si Ayutthaya	120.00	11.00	1.50	6	-	-	6x20	-
21	Phuket	90.00	11.00	1.50	5	2x15	-	3x20	-
22	Patthalung	140.00	11.00	1.50	8	2x10	-	6x20	-
23	Phetchaburi	130.00	11.00	1.50	13	13x10	-	-	-
24	Pattani	120.00	11.00	1.50	7	2x10	-	5x20	-
25	Narathiwat	80.00	11.00	1.50	4	-	-	4x20	-

Appendix Table A4 (cont'd)

No.	Province	project characteristic							
		Length (m.)	Width (m.)	sidewalk (m.)	No. of span	R.C.Slab (mxl)	I-Girder (mxl)	box-Girder (mxl)	plank-girder (mxl)
26	Nakhon Sawan	410.00	11.00	1.50	25	7x10	8x30	-	-
27	Suphan Buri	254.40	11.00	1.50	11	-	8x20+3x30	-	-
28	Uttaradit	100.00	11.00	1.50	5	-	-	5x20	-
29	Amnat Charoen	100.00	11.00	1.50	5	-	5x20	-	-
30	Ang Thong	60.00	11.00	1.50	7	1x10+3x10+1x20		-	-
31	Surat Thani	120.00	11.00	1.50	7	2x10	-	5x20	-
32	Surat Thani	200.00	11.00	1.50	8	-	4x30	4x20	-
33	Phra Nakhon Si Ayutthaya	60.00	11.00	1.50	4	2x10	-	2x20	-

Appendix Table A5 Construction cost of concrete bridge 2002

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
1	Trang	160.00	June	8,205,959.05	13,723,519.66	21,929,478.71	137,059.24
2	Nakhon Si Thammarat	60.00	June	3,117,701.22	4,216,687.63	7,334,388.85	122,239.81
3	Surat Thani	90.00	June	4,749,915.26	5,397,049.64	10,146,964.90	112,744.05
4	Buri Ram	330.00	June	14,300,620.40	15,460,104.80	29,760,725.20	90,184.02
5	Trat	70.00	June	3,831,346.91	1,704,859.47	5,536,206.38	79,088.66
6	Samut Sakhon	170.00	June	8,196,514.30	6,956,252.00	15,152,766.30	89,133.92
7	Samut Songkhram	170.00	June	8,196,514.30	7,057,684.96	15,254,199.26	89,730.58
8	Samut Songkhram	120.00	June	6,340,566.94	7,294,676.08	13,635,243.02	113,627.03
9	Suphan Buri	100.00	June	5,072,742.45	4,136,360.31	9,209,102.76	92,091.03
10	Nakhon pathom	80.00	June	3,426,807.14	3,803,145.44	7,229,952.58	90,374.41
11	Nan	130.00	March	8,478,956.26	6,870,195.58	15,349,151.84	118,070.40
12	Chumphon	120.00	June	8,336,805.12	5,538,103.40	13,874,908.52	115,624.24
13	Chumphon	100.00	June	4,090,049.00	4,564,352.00	8,654,401.00	86,544.01
14	Krabi	80.00	June	4,834,432.51	3,693,053.95	8,527,486.46	106,593.58

Appendix Table A5 (cont'd)

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
15	Patthalung	140.00	June	5,749,281.33	4,719,797.31	10,469,078.64	74,779.13
16	Patthalung	100.00	March	5,831,443.00	3,937,499.00	9,768,942.00	97,689.42
17	Trang	160.00	June	3,024,338.15	17,214,783.07	20,239,121.22	126,494.51
18	Tak	390.00	June	15,589,659.00	11,828,228.00	27,417,887.00	70,302.27
19	Nakhon Nayok	65.00	June	4,396,622.00	3,857,715.00	8,254,337.00	126,989.80
20	Trang	180.00	June	8,152,633.00	5,184,638.00	13,337,271.00	74,095.95
21	Phrachin Buri	140.00	March	8,136,110.00	8,098,165.00	16,234,275.00	115,959.11
22	Chaing Mai	74.00	February	2,671,846.00	3,527,609.00	6,199,455.00	83,776.42
23	Kalasin	120.00	March	5,967,937.00	4,328,841.00	10,296,778.00	85,806.48
24	Phangnga	160.00	February	6,948,468.00	4,369,239.00	11,317,707.00	70,735.67
25	Phra Nakhon Si Ayutthaya	110.00	March	4,466,038.00	3,671,636.00	8,137,674.00	73,978.85
26	Phitsanulok	130.00	March	5,318,622.00	4,148,776.00	9,467,398.00	72,826.14
27	Phetchaburi	200.00	March	9,949,778.00	6,264,952.00	16,214,730.00	81,073.65
28	Phetchabun	100.00	March	5,862,198.00	5,647,798.00	11,509,996.00	115,099.96

Appendix Table A5 (cont'd)

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
29	Phrae	140.00	March	6,122,235.00	4,203,332.00	10,325,567.00	73,754.05
30	Phayao	140.00	February	5,586,146.00	3,879,268.00	9,465,414.00	67,610.10
31	Ratchaburi	250.00	March	10,055,708.00	7,328,584.00	17,384,292.00	69,537.17
32	Roi Et	330.00	March	10,266,187.00	7,894,400.00	18,160,587.00	55,032.08
33	Sakon Nakhon	180.00	March	6,156,918.00	5,172,188.00	11,329,106.00	62,939.48
34	Songkhla	80.00	March	4,609,081.00	3,794,848.00	8,403,929.00	105,049.11
35	Satun	190.00	March	10,579,582.00	6,120,146.00	16,699,728.00	87,893.31
36	Suphan Buri	150.00	March	5,136,524.00	4,869,075.00	10,005,599.00	66,703.99
37	Sukhothai	220.00	March	12,234,015.00	12,952,027.00	25,186,042.00	114,482.01
38	Surin	140.00	March	6,232,176.00	5,982,954.00	12,215,130.00	87,250.93
39	Uthai Thani	60.00	June	2,838,916.00	2,498,843.00	5,337,759.00	88,962.65
40	Uttaradit	100.00	June	4,249,900.00	1,139,200.00	5,389,100.00	53,891.00
41	Satun	120.00	June	6,987,207.83	1,901,648.12	8,888,855.95	74,073.80
	AVERAGE						**92,141.49**

Appendix Table A6 Construction cost of concrete bridge 2002 (super - structure)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
1	160.00	-	7,065,546.01	-	-	580,469.76	484,997.76	74,945.52	8,205,959.05
2	60.00	689,128.74	-	2,029,781.79	-	179,325.36	161,686.80	57,778.53	3,117,701.22
3	90.00	1,022,362.83	-	3,115,877.64	-	282,792.96	273,955.68	54,926.15	4,749,915.26
4	330.00	-	5,319,818.76	-	6,855,625.64	1,128,020.23	922,766.63	74,389.14	14,300,620.40
5	70.00	3,227,650.34	-	-	-	257,469.03	279,554.39	66,673.15	3,831,346.91
6	170.00	2,157,689.41	-	4,882,018.84	-	555,980.17	535,670.25	65,155.63	8,196,514.30
7	170.00	2,157,689.41	-	4,882,018.84	-	555,980.17	535,670.25	65,155.63	8,196,514.30
8	120.00	2,082,377.58	-	3,245,213.80	-	453,492.34	491,633.57	67,849.65	6,340,566.94
9	100.00	1,262,341.60	-	2,995,312.67	-	336,416.40	418,380.11	60,291.67	5,072,742.45
10	80.00	-	2,848,607.26	-	-	265,950.03	244,794.43	67,455.42	3,426,807.14
11	130.00	346,635.60	3,696,371.28	3,339,517.84	-	501,899.84	521,752.11	72,779.58	8,478,956.25
12	120.00	-	7,411,896.58	-	-	432,552.96	415,134.72	77,220.86	8,336,805.12
13	100.00	-	-	3,573,700.00	-	242,200.00	215,629.00	58,520.00	4,090,049.00
14	80.00	-	-	4,225,374.72	-	284,497.92	259,338.24	65,221.63	4,834,432.51
15	140.00	-	-	5,002,370.80	-	352,408.00	320,812.80	73,689.73	5,749,281.33
16	100.00	-	-	5,044,450.00	-	387,800.00	330,529.00	68,664.00	5,831,443.00

Appendix Table A6 (cont'd)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
17	160.00	-	1,883,925.11	-	-	580,469.76	484,997.76	74,945.52	3,024,338.15
18	390.00	2,787,360.00	10,796,460.00	-	-	935,220.00	996,193.00	74,426.00	15,589,659.00
19	65.00	270,998.00	-	3,608,985.00	-	160,242.00	315,394.00	41,003.00	4,396,622.00
20	180.00	-	-	7,116,120.00	-	538,560.00	440,078.00	57,875.00	8,152,633.00
21	140.00	-	-	7,049,560.00	-	571,760.00	470,238.00	44,552.00	8,136,110.00
22	74.00	-	-	2,090,400.00	-	258,300.00	244,800.00	78,346.00	2,671,846.00
23	120.00	-	4,998,390.00	-	-	473,520.00	424,571.00	71,456.00	5,967,937.00
24	160.00	-	-	6,103,360.00	-	412,800.00	378,472.00	53,836.00	6,948,468.00
25	110.00	697,620.00	-	3,040,560.00	-	283,580.00	376,470.00	67,808.00	4,466,038.00
26	130.00	-	-	4,633,200.00	-	336,960.00	298,782.00	49,680.00	5,318,622.00
27	200.00	1,258,840.00	-	7,740,960.00	-	444,800.00	431,200.00	73,978.00	9,949,778.00
28	100.00	-	-	5,070,000.00	-	380,000.00	344,700.00	67,498.00	5,862,198.00
29	140.00	-	-	5,615,960.00	-	238,000.00	230,775.00	37,500.00	6,122,235.00
30	140.00	-	-	4,764,200.00	-	588,000.00	168,330.00	65,616.00	5,586,146.00
31	250.00	804,960.00	8,012,865.00	-	-	622,750.00	560,310.00	54,823.00	10,055,708.00
32	330.00	5,100,060.00	3,462,855.00	-	-	848,760.00	790,921.00	63,591.00	10,266,187.00

Appendix Table A6 (cont'd)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
33	180.00	-	5,370,750.00	-	-	374,220.00	365,384.00	46,564.00	6,156,918.00
34	80.00	675,600.00	-	3,285,000.00	-	305,600.00	276,336.00	66,545.00	4,609,081.00
35	190.00	-	9,215,125.00	-	-	668,800.00	627,835.00	67,822.00	10,579,582.00
36	150.00	1,927,200.00	2,460,100.00	-	-	350,400.00	340,472.00	58,352.00	5,136,524.00
37	220.00	-	-	10,710,490.00	-	743,600.00	709,386.00	70,539.00	12,234,015.00
38	140.00	-	5,258,820.00	-	-	464,520.00	440,373.00	68,463.00	6,232,176.00
39	60.00	-	-	2,478,060.00	-	166,680.00	146,399.00	47,777.00	2,838,916.00
40	100.00	-	-	3,663,000.00	-	266,000.00	265,000.00	55,900.00	4,249,900.00
41	119.00	-	2,146,320.25	3,976,232.33	-	421,393.20	374,894.64	68,367.41	6,987,207.83

Appendix Table A7 Construction cost of concrete bridge 2002 (sub - suructure)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
1	Trang	160.00	11.00	12,629,826.79	2,714,143.23	74,945.52	15,418,915.54
2	Nakhon Si Thammarat	60.00	11.00	2,820,050.52	1,353,459.38	57,778.53	4,231,288.43
3	Surat Thani	90.00	11.00	3,209,730.78	2,143,868.90	54,926.15	5,408,525.83
4	Buri Ram	330.00	11.00	8,684,049.83	6,292,783.46	74,389.14	15,051,222.43
5	Trat	70.00	11.00	1,180,267.86	516,240.27	66,673.15	1,763,181.28
6	Samut Sakhon	170.00	11.00	4,310,257.98	2,597,437.31	65,155.63	6,972,850.92
7	Samut Songkhram	170.00	11.00	4,310,257.98	2,343,118.86	65,155.63	6,718,532.47
8	Samut Songkhram	120.00	11.00	4,098,034.16	3,145,445.00	67,849.65	7,311,328.81
9	Suphan Buri	100.00	11.00	2,244,205.77	1,831,862.87	60,291.67	4,136,360.31
10	Nakhon pathom	80.00	11.00	1,927,184.47	1,845,551.41	67,455.42	3,840,191.30
11	Nan	130.00	11.00	2,372,126.65	4,471,734.54	72,779.58	6,916,640.77
12	Chumphon	120.00	11.00	2,716,471.30	2,797,720.13	77,220.86	5,591,412.29
13	Chumphon	100.00	11.00	2,822,400.00	1,530,457.00	58,520.00	4,411,377.00
14	Krabi	80.00	11.00	440,584.70	3,229,063.49	65,221.63	3,734,869.82
15	Patthalung	140.00	11.00	810,128.27	3,891,896.74	73,689.73	4,775,714.74

Appendix Table A7 (cont'd)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
16	Patthalung	100.00	11.00	756,448.00	3,125,022.00	68,664.00	3,950,134.00
17	Trang	160.00	11.00	14,145,406.00	3,039,840.41	74,945.52	17,260,191.93
18	Tak	390.00	11.00	5,649,800.00	6,174,232.00	74,426.00	11,898,458.00
19	Nakhon Nayok	65.00	11.00	1,694,915.00	1,849,856.00	41,003.00	3,585,774.00
20	Trang	180.00	11.00	2,253,348.00	2,893,272.00	57,875.00	5,204,495.00
21	Phrachin Buri	140.00	11.00	4,399,416.00	3,646,202.00	44,552.00	8,090,170.00
22	Chaing Mai	74.00	11.00	1,465,680.00	2,016,539.00	78,346.00	3,560,565.00
23	Kalasin	120.00	11.00	1,753,290.00	2,524,921.00	71,456.00	4,349,667.00
24	Phangnga	160.00	11.00	1,975,272.00	2,361,542.00	53,836.00	4,390,650.00
25	Phra Nakhon Si Ayutthaya	110.00	11.00	2,021,580.00	1,604,963.00	67,808.00	3,694,351.00
26	Phitsanulok	130.00	11.00	2,090,880.00	2,021,760.00	49,680.00	4,162,320.00
27	Phetchaburi	200.00	11.00	2,011,360.00	4,215,958.00	73,978.00	6,301,296.00
28	Phetchabun	100.00	11.00	2,022,048.00	3,572,380.00	67,498.00	5,661,926.00
29	Phrae	140.00	11.00	1,310,350.00	2,849,000.00	37,500.00	4,196,850.00

Appendix Table A7 (cont'd)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
30	Phayao	140.00	11.00	1,466,454.00	2,382,000.00	65,616.00	3,914,070.00
31	Ratchaburi	250.00	11.00	3,097,644.00	4,182,533.00	54,823.00	7,335,000.00
32	Roi Et	330.00	11.00	3,844,452.00	3,985,794.00	63,591.00	7,893,837.00
33	Sakon Nakhon	180.00	11.00	2,061,850.00	3,080,000.00	46,564.00	5,188,414.00
34	Songkhla	80.00	11.00	1,529,088.00	2,216,020.00	66,545.00	3,811,653.00
35	Satun	190.00	11.00	2,167,776.00	3,913,270.00	67,822.00	6,148,868.00
36	Suphan Buri	150.00	11.00	1,883,448.00	29,419,000.00	58,352.00	31,360,800.00
37	Sukhothai	220.00	11.00	5,641,632.00	7,256,395.00	70,539.00	12,968,566.00
38	Surin	140.00	11.00	2,860,993.00	3,077,200.00	68,463.00	6,006,656.00
39	Uthai Thani	60.00	11.00	1,469,757.00	988,836.00	47,777.00	2,506,370.00
40	Uttaradit	100.00	11.00	2,386,000.00	2,017,800.00	55,900.00	4,459,700.00
41	Satun	120.00	11.00	1,806,527.18	3,060,065.39	68,367.41	4,934,959.98

Appendix Table A8 Project characteristic concrete bridge 2002

No.	project characteristic								
	Province	Length (m.)	width (m.)	sidewalk (m.)	No. of span	R.C.Slab	I-Girder	box-Girder	plank-girder
1	Trang	160.00	11.00	1.50	6	-	(2x20)+(4x30)	-	-
2	Nakhon Si Thammarat	60.00	11.00	1.50	4	2x10	-	2x20	-
3	Surat Thani	90.00	11.00	1.50	5	3x10	-	3x20	-
4	Buri Ram	330.00	11.00	1.50	30	-	6x20	21x10	-
5	Trat	70.00	11.00	1.50	4	1x10	-	3x20	-
6	Samut Sakhon	170.00	11.00	1.50	12	7x10	-	5x20	-
7	Samut Songkhram	170.00	11.00	1.50	12	7x10	-	5x20	-
8	Samut Songkhram	120.00	11.00	1.50	7	3x10	-	4x20	-
9	Suphan Buri	100.00	11.00	1.50	9	9x10	-	-	-
10	Nakhon pathom	80.00	11.00	1.50	9	5x10	-	4x20	-
11	Nan	130.00	11.00	1.50	5	2x10	-	-	-
12	Chumphon	120.00	11.00	1.50	6	-	6x20	-	-
13	Chumphon	100.00	11.00	1.50	5	-	-	5x20	-
14	Krabi	80.00	11.00	1.50	4	-	-	4x20	-
15	Patthalung	140.00	11.00	1.50	7	-	-	7x20	-
16	Patthalung	100.00	11.00	1.50	5	-	-	5x20	-
17	Trang	160.00	11.00	1.50	6	-	(2x20)+(4x30)	-	-
18	Tak	390.00	11.00	1.50	21	12x10	9x30	-	-
19	Nakhon Nayok	65.00	11.00	1.50	4	1x5	-	3x20	-
20	Trang	180.00	11.00	1.50	9	-	-	9x20	-
21	Phrachin Buri	140.00	11.00	1.50	7	-	-	7x20	-

Appendix Table A8 (cont'd)

No.	project characteristic								
	Province	Length (m.)	width (m.)	sidewalk (m.)	No. of span	R.C.Slab	I-Girder	box-Girder	plank-girder
22	Chaing Mai	74.00	11.00	1.50	6	(2x7)+(2x10)	-	2x20	-
23	Kalasin	120.00	11.00	1.50	6	-	6x20	-	-
24	Phangnga	160.00	11.00	1.50	8	-	-	8x20	-
25	Phra Nakhon Si Ayutthaya	110.00	11.00	1.50	7	3x10	-	4x20	-
26	Phitsanulok	130.00	11.00	1.50	8	3x10	-	5x20	-
27	Phetchaburi	200.00	11.00	1.50	12	4x10	-	8x20	-
28	Phetchabun	100.00	11.00	1.50	5	-	-	5x20	-
29	Phrae	140.00	11.00	1.50	7	-	-	7x20	-
30	Phayao	140.00	11.00	1.50	7	-	-	7x20	-
31	Ratchaburi	250.00	11.00	1.50	27	21x10	6x20	-	-
32	Roi Et	330.00	11.00	1.50	27	21x10	6x20	-	-
33	Sakon Nakhon	180.00	11.00	1.50	9	-	9x20	-	-
34	Songkhla	80.00	11.00	1.50	5	2x10	-	3x20	-
35	Satun	190.00	11.00	1.50	7	-	(2x20)+(5x30)	-	-
36	Suphan Buri	150.00	11.00	1.50	11	8x10	(2x20)+(1x30)	-	-
37	Sukhothai	220.00	11.00	1.50	11	-	-	11x20	-
38	Surin	140.00	11.00	1.50	7	-	7x20	-	-
39	Uthai Thani	60.00	11.00	1.50	3	-	-	3x20	-
40	Uttaradit	100.00	11.00	1.50	5	-	-	5x20	-
41	Satun	120.00	11.00	1.50	5	-	2x30	3x20	-

Appendix Table A9 Construction cost of concrete bridge 2003

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
1	Lop Buri	120.00	June	6,523,528.99	5,038,528.68	11,562,057.67	96,350.48
2	Chumphon	100.00	June	6,298,218.10	4,108,188.27	10,406,406.37	104,064.06
3	Yala	150.00	June	9,169,724.48	8,219,778.52	17,389,503.00	115,930.02
4	Chunthaburi	60.00	June	2,465,922.51	1,021,021.29	3,486,943.80	58,115.73
5	Phra Nakhon Si Ayutthaya	120.00	June	6,408,773.30	3,967,828.53	10,376,601.83	86,471.68
6	Si Sa Ket	100.00	June	3,301,614.11	5,025,862.02	8,327,476.13	83,274.76
7	Si Sa Ket	100.00	June	4,989,860.78	5,111,955.75	10,101,816.53	101,018.17
8	Prachuap Khiri Khan	90.00	June	4,918,489.63	3,254,625.77	8,173,115.40	90,812.39
9	Nong Khai	160.00	June	5,042,898.56	5,661,337.49	10,704,236.05	66,901.48
10	Chachoengsao	100.00	June	5,117,793.10	6,645,451.78	11,763,244.88	117,632.45
11	Phetchaburi	100.00	June	5,646,034.83	6,158,241.62	11,804,276.45	118,042.76
12	Surat Thani	130.00	June	7,894,619.21	9,315,611.52	17,210,230.73	132,386.39
13	Trang	80.00	March	4,899,199.40	2,301,933.71	7,201,133.11	90,014.16
14	Narathiwat	100.00	June	6,182,373.12	3,412,721.72	9,595,094.84	95,950.95

Appendix Table A9 (cont'd)

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
15	Patthalung	80.00	June	5,485,632.78	2,135,870.89	7,621,503.67	95,268.80
16	Chumphon	100.00	June	6,883,595.40	3,699,554.17	10,583,149.57	105,831.50
17	Nakhon Si Thammarat	70.00	June	3,914,248.09	4,800,242.55	8,714,490.64	124,492.72
18	Narathiwat	60.00	June	3,311,874.88	3,803,275.64	7,115,150.52	118,585.84
19	Krabi	80.00	June	3,944,870.00	2,724,725.00	6,669,595.00	83,369.94
20	Khon Kaen	110.00	June	3,963,391.00	3,752,607.00	7,715,998.00	70,145.44
21	Chachoengsao	210.00	June	10,982,150.00	10,789,494.00	21,771,644.00	103,674.50
22	Chai Nat	530.00	August	21,213,419.00	31,716,445.00	52,929,864.00	99,867.67
23	Chumphon	100.00	June	4,513,617.00	2,732,734.00	7,246,351.00	72,463.51
24	Chumphon	100.00	June	4,171,124.00	3,882,214.00	8,053,338.00	80,533.38
25	Chaing Mai	240.00	June	11,638,334.00	9,321,388.00	20,959,722.00	87,332.18
26	Mae Hong Son	170.00	June	11,069,803.00	6,703,768.00	17,773,571.00	104,550.42
27	Mae Hong Son	160.00	June	10,387,748.00	5,539,441.00	15,927,189.00	99,544.93
28	Maha Sarakham	140.00	June	4,557,620.00	6,296,620.00	10,854,240.00	77,530.29

Appendix Table A9 (cont'd)

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
29	Phrae	150.00	June	6,081,888.00	5,038,222.00	11,120,110.00	74,134.07
30	Phetchabun	100.00	June	6,072,957.00	4,127,194.00	10,200,151.00	102,001.51
31	Phetchabun	100.00	June	6,531,300.00	3,932,940.00	10,464,240.00	104,642.40
32	Phetchaburi	240.00	June	11,963,970.00	11,327,420.00	23,291,390.00	97,047.46
33	Phetchaburi	60.00	June	3,622,800.00	2,607,180.00	6,229,980.00	103,833.00
34	Phitsanulok	160.00	July	11,482,866.00	12,852,425.00	24,335,291.00	152,095.57
35	Phichit	170.00	June	8,035,295.62	4,705,166.00	12,740,461.62	74,943.89
36	Phrachin Buri	110.00	June	5,510,478.00	6,690,372.00	12,200,850.00	110,916.82
37	Phangnga	100.00	June	4,790,958.00	4,472,672.00	9,263,630.00	92,636.30
38	Prachuap Khiri Khan	90.00	July	3,649,094.00	2,148,746.00	5,797,840.00	64,420.44
39	Nan	150.00	July	9,508,470.00	9,412,550.00	18,921,020.00	126,140.13
40	Narathiwat	60.00	June	3,620,979.00	3,030,830.00	6,651,809.00	110,863.48
41	Nakhon Si Thammarat	100.00	June	6,049,550.00	4,423,803.00	10,473,353.00	104,733.53
42	Nakhon Ratchasima	110.00	June	3,859,916.00	3,955,968.00	7,815,884.00	71,053.49

Appendix Table A9 (cont'd)

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
43	Nakhon Phanom	210.00	June	7,192,588.00	12,119,030.00	19,311,618.00	91,960.09
44	Nakhon Nayok	80.00	June	4,328,500.00	3,657,092.00	7,985,592.00	99,819.90
45	Trang	90.00	March	3,743,170.00	2,740,070.00	6,483,240.00	72,036.00
46	Ubon Ratchathani	160.00	June	7,263,300.00	7,728,446.00	14,991,746.00	93,698.41
47	Lampang	160.00	June	7,638,115.00	6,383,152.00	14,021,267.00	87,632.92
48	Yala	50.00	August	2,444,300.00	5,648,350.00	8,092,650.00	161,853.00
49	Ratchaburi	190.00	June	10,394,140.00	9,489,160.00	19,883,300.00	104,648.95
	AVERAGE						**97,576.91**

Appendix Table A10 Construction cost of concrete bridge 2003 (super - structure)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
1	120.00	1,313,203.42	-	4,244,596.10	-	432,176.35	456,422.05	77,131.07	6,523,528.99
2	100.00	-	-	5,523,078.60	-	374,404.80	340,368.00	60,366.70	6,298,218.10
3	150.00	-	7,873,586.29	-	-	615,519.00	608,277.60	72,341.59	9,169,724.48
4	60.00	-	-	-	1,986,403.38	221,580.79	201,149.06	56,789.27	2,465,922.50
5	120.00	2,061,930.18	-	3,319,677.75	-	464,336.40	491,868.47	70,960.50	6,408,773.30
6	100.00	-	2,032,573.28	-	603,421.37	309,901.65	276,634.02	79,082.79	3,301,613.11
7	100.00	2,031,976.26	-	2,171,880.28	-	369,507.50	345,219.35	71,277.39	4,989,860.78
8	90.00	-	4,145,001.49	-	-	356,306.04	338,710.68	78,470.42	4,918,488.63
9	160.00	-	-	3,589,684.90	-	688,703.36	687,670.79	76,839.51	5,042,898.56
10	100.00	-	-	3,774,192.22	641,298.15	353,417.42	337,049.61	11,835.69	5,117,793.09
11	100.00	-	4,831,033.99	-	-	364,508.10	373,099.20	77,393.54	5,646,034.83
12	130.00	-	6,796,869.61	-	-	521,070.68	511,653.74	65,025.18	7,894,619.21
13	80.00	-	4,167,447.17	-	-	333,227.20	329,306.88	69,218.15	4,899,199.40
14	100.00	-	5,275,827.90	-	-	423,864.00	411,684.00	70,997.22	6,182,373.12
15	80.00	-	-	4,690,261.56	-	334,913.76	323,162.40	137,295.06	5,485,632.78
16	100.00	-	5,976,992.28	-	-	424,107.60	399,733.60	82,761.92	6,883,595.40

Appendix Table A10 (cont'd)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
17	70.00	-	2,793,926.81	-	507,640.14	291,678.58	206,598.07	60,404.50	3,860,248.10
18	60.00	-	-	2,903,724.00	-	233,768.16	99,976.32	74,706.40	3,312,174.88
19	80.00	-	3,401,440.00	3,401,440.00	-	237,440.00	216,342.00	89,648.00	7,346,310.00
20	110.00	218,950.00	3,157,800.00	-	-	292,600.00	232,227.00	61,814.00	3,963,391.00
21	210.00	-	9,524,325.00	-	-	706,860.00	647,289.00	103,676.00	10,982,150.00
22	530.00	-	18,381,905.00	-	-	1,262,460.00	1,312,272.00	256,782.00	21,213,419.00
23	100.00	-	-	3,941,700.00	-	272,000.00	250,865.00	49,052.00	4,513,617.00
24	100.00	481,760.00	-	3,105,240.00	-	275,200.00	263,504.00	45,420.00	4,171,124.00
25	240.00	4,609,640.00	-	5,213,350.00	-	884,640.00	853,415.00	77,289.00	11,638,334.00
26	170.00	683,240.00	9,070,790.00	-	-	651,780.00	590,733.00	73,260.00	11,069,803.00
27	160.00		9,144,700.00	-	-	614,720.00	556,339.00	71,989.00	10,387,748.00
28	140.00	-	3,840,830.00	-	-	351,120.00	302,722.00	62,948.00	4,557,620.00
29	150.00	251,220.00	-	5,023,550.00	-	405,820.00	345,379.00	55,919.00	6,081,888.00
30	100.00	-	-	5,300,550.00	-	357,200.00	338,927.00	76,280.00	6,072,957.00
31	100.00	-	-	5,690,000.00	-	390,000.00	360,800.00	90,500.00	6,531,300.00

Appendix Table A10 (cont'd)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
32	240.00	-	-	10,229,640.00	-	797,280.00	865,697.00	71,353.00	11,963,970.00
33	60.00	-	-	3,117,540.00	-	203,040.00	232,382.00	69,838.00	3,622,800.00
34	160.00	1,172,610.00	5,637,483.69	2,360,492.31	-	473,280.00	1,715,692.00	123,308.00	11,482,866.00
35	170.00	470,560.00	6,640,304.62	-	-	413,780.00	449,895.00	60,756.00	8,035,295.62
36	110.00	1,658,950.00	-	2,926,140.00	-	-	835,425.00	89,963.00	5,510,478.00
37	100.00	426,100.00	-	3,588,560.00	-	371,400.00	336,657.00	68,241.00	4,790,958.00
38	90.00		3,127,955.00	-	-	233,460.00	242,959.00	44,720.00	3,649,094.00
39	150.00	336,370.00	3,906,924.29	4,112,525.71	-	551,700.00	532,279.00	68,671.00	9,508,470.00
40	60.00	-	-	3,025,740.00	-	206,880.00	227,739.00	160,620.00	3,620,979.00
41	100.00	-	-	5,250,000.00	-	360,000.00	373,550.00	66,000.00	6,049,550.00
42	110.00	220,000.00	3,041,475.00	-	-	297,880.00	236,457.00	64,104.00	3,859,916.00
43	210.00	-	6,074,215.00	-	-	541,380.00	511,906.00	65,087.00	7,192,588.00
44	80.00	654,400.00	-	3,056,925.00	-	286,731.00	266,337.00	64,107.00	4,328,500.00
45	90.00	234,400.00	-	3,006,800.00	-	215,640.00	240,184.00	46,146.00	3,743,170.00
46	160.00	-	6,192,000.00	-	-	544,000.00	436,100.00	91,200.00	7,263,300.00
47	160.00	1,024,400.00	-	5,895,060.00	-	355,520.00	287,826.00	75,309.00	7,638,115.00

Appendix Table A10 (cont'd)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
48	50.00	581,940.00	1,514,370.00	-	-	144,100.00	164,050.00	39,870.00	2,444,330.00
49	190.00	1,131,800.00	7,937,950.00	-	-	644,100.00	592,542.00	87,748.00	10,394,140.00

Appendix Table A11 Construction cost of concrete bridge 2003 (sub - stucture)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
1	Lop Buri	120.00	11.00	2,876,706.56	2,110,625.99	51,196.13	5,038,528.68
2	Chumphon	100.00	11.00	2,272,924.02	1,810,830.70	24,433.56	4,108,188.28
3	Yala	150.00	11.00	5,847,971.19	2,351,934.31	19,873.02	8,219,778.52
4	Chunthaburi	60.00	11.00	458,831.14	559,784.54	2,405.61	1,021,021.29
5	Phra Nakhon Si Ayutthaya	120.00	11.00	1,881,136.17	2,035,625.06	51,067.30	3,967,828.53
6	Si Sa Ket	100.00	11.00	2,551,253.84	2,447,938.32	26,669.86	5,025,862.02
7	Si Sa Ket	100.00	11.00	2,183,752.98	2,885,793.00	42,409.77	5,111,955.75
8	Prachuap Khiri Khan	90.00	11.00	1,811,234.10	1,408,007.59	35,384.09	3,254,625.78
9	Nong Khai	160.00	11.00	2,876,186.53	2,608,756.58	176,394.39	5,661,337.50
10	Chachoengsao	100.00	11.00	4,024,967.03	2,616,517.79	3,966.97	6,645,451.79
11	Phetchaburi	100.00	11.00	3,567,564.73	2,374,935.96	215,740.93	6,158,241.62
12	Surat Thani	130.00	11.00	7,106,293.36	2,189,438.55	19,879.61	9,315,611.52
13	Trang	80.00	11.00	653,909.38	1,627,851.63	20,172.70	2,301,933.71
14	Narathiwat	100.00	11.00	1,875,111.00	1,517,554.92	20,055.80	3,412,721.72

Appendix Table A11 (cont'd)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
15	Patthalung	80.00	11.00	851,777.74	1,259,488.73	24,604.41	2,135,870.88
16	Chumphon	100.00	11.00	738,836.88	2,940,649.98	20,067.32	3,699,554.18
17	Nakhon Si Thammarat	70.00	11.00	3,516,834.66	1,263,322.46	20,085.43	4,800,242.55
18	Narathiwat	60.00	11.00	2,501,182.09	1,277,467.03	24,626.52	3,803,275.64
19	Krabi	80.00	11.00	578,650.00	2,109,345.00	36,730.00	2,724,725.00
20	Khon Kaen	110.00	11.00	1,476,792.00	2,261,385.00	14,430.00	3,752,607.00
21	Chachoengsao	210.00	11.00	6,553,155.00	4,200,089.00	36,250.00	10,789,494.00
22	Chai Nat	530.00	11.00	8,342,000.00	23,272,266.00	102,180.00	31,716,446.00
23	Chumphon	100.00	11.00	1,003,754.00	1,691,600.00	37,380.00	2,732,734.00
24	Chumphon	100.00	11.00	1,630,844.00	2,214,050.00	37,320.00	3,882,214.00
25	Chaing Mai	240.00	11.00	3,213,090.00	6,059,238.00	49,060.00	9,321,388.00
26	Mae Hong Son	170.00	11.00	2,754,208.00	3,896,510.00	53,050.00	6,703,768.00
27	Mae Hong Son	160.00	11.00	2,059,331.00	3,427,290.00	52,820.00	5,539,441.00
28	Maha Sarakham	140.00	11.00	3,748,482.00	2,528,778.00	19,360.00	6,296,620.00
29	Phrae	150.00	11.00	1,986,628.00	3,012,484.00	39,110.00	5,038,222.00

Appendix Table A11 (cont'd)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
30	Phetchabun	100.00	11.00	1,851,624.00	2,212,710.00	62,860.00	4,127,194.00
31	Phetchabun	100.00	11.00	1,638,240.00	2,245,620.00	49,080.00	3,932,940.00
32	Phetchaburi	240.00	11.00	6,616,290.00	4,659,110.00	52,020.00	11,327,420.00
33	Phetchaburi	60.00	11.00	1,111,570.00	1,441,890.00	53,720.00	2,607,180.00
34	Phitsanulok	160.00	11.00	5,026,374.00	7,773,540.00	52,511.00	12,852,425.00
35	Phichit	170.00	11.00	2,260,240.00	2,402,840.00	42,086.00	4,705,166.00
36	Phrachin Buri	110.00	11.00	2,689,792.00	3,981,510.00	19,070.00	6,690,372.00
37	Phangnga	100.00	11.00	1,723,012.00	2,712,370.00	37,290.00	4,472,672.00
38	Prachuap Khiri Khan	90.00	11.00	849,576.00	1,265,470.00	33,700.00	2,148,746.00
39	Nan	150.00	11.00	3,404,810.00	5,936,910.00	70,830.00	9,412,550.00
40	Narathiwat	60.00	11.00	1,566,900.00	1,437,360.00	26,570.00	3,030,830.00
41	Nakhon Si Thammarat	100.00	11.00	1,841,000.00	2,538,000.00	44,803.00	4,423,803.00
42	Nakhon Ratchasima	110.00	11.00	2,072,848.00	1,868,510.00	14,610.00	3,955,968.00
43	Nakhon Phanom	210.00	11.00	6,570,200.00	5,520,760.00	28,070.00	12,119,030.00
44	Nakhon Nayok	80.00	11.00	1,726,692.00	1,879,455.00	50,945.00	3,657,092.00

Appendix Table A11 (cont'd)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
45	Trang	90.00	11.00	1,275,400.00	1,425,310.00	39,360.00	2,740,070.00
46	Ubon Ratchathani	160.00	11.00	3,505,814.00	4,199,166.00	23,466.00	7,728,446.00
47	Lampang	160.00	11.00	2,895,792.00	3,469,790.00	17,570.00	6,383,152.00
48	Yala	50.00	11.00	4,366,080.00	1,242,400.00	39,870.00	5,648,350.00
49	Ratchaburi	190.00	11.00	4,460,832.00	4,940,580.00	87,748.00	9,489,160.00

Appendix Table A12 Project characteristic concrete bridge 2003

No.	Province	project characteristic							
		Length (m.)	width (m.)	sidewalk (m.)	No. of span	R.C.Slab	I-Girder	box-Girder	plank-girder
1	Lop Buri	120.00	11.00	1.50	7	2x10	-	5x20	-
2	Chumphon	100.00	11.00	1.50	5	3x10	-	4x20	-
3	Yala	150.00	11.00	1.50	7	-	(6x20)+(1x30)	-	-
4	Chunthaburi	60.00	11.00	1.50	6	-	-	-	6x10
5	Phra Nakhon Si Ayutthaya	120.00	11.00	1.50	7	2x10	-	5x20	-
6	Si Sa Ket	100.00	11.00	1.50	6	-	4x20	-	2x10
7	Si Sa Ket	100.00	11.00	1.50	7	4x10	-	3x20	-
8	Prachuap Khiri Khan	90.00	11.00	1.50	4	-	(3x20)+(1x30)	-	-
9	Nong Khai	160.00	11.00	1.50	8	-	-	8x20	-
10	Chachoengsao	100.00	11.00	1.50	6	-	-	4x20	2x10
11	Phetchaburi	100.00	11.00	1.50	5	-	5x20	-	-
12	Surat Thani	130.00	11.00	1.50	5	-	(2x20)+(3x30)	-	-
13	Trang	80.00	11.00	1.50	4	-	4x20	-	-
14	Narathiwat	100.00	11.00	1.50	5	-	5x20	-	-
15	Patthalung	80.00	11.00	1.50	4	-	-	4x20	-
16	Chumphon	100.00	11.00	1.50	5	-	-	5x20	-
17	Nakhon Si Thammarat	70.00	11.00	1.50	4	-	3x20	-	1x10
18	Narathiwat	60.00	11.00	1.50	3	-	-	3x20	-
19	Krabi	80.00	11.00	1.50	4	-	-	4x20	-

Appendix Table A12 (cont'd)

No.	Province	project characteristic							
		Length (m.)	width (m.)	sidewalk (m.)	No. of span	R.C.Slab	I-Girder	box-Girder	plank-girder
20	Khon Kaen	110.00	11.00	1.50	6	1x10	5x20	-	-
21	Chachoengsao	210.00	11.00	1.50	9	-	(6x20)+(3x30)	-	-
22	Chai Nat	530.00	11.00	1.50	19	-	(10x20)+(9x30)	-	-
23	Chumphon	100.00	11.00	1.50	5	-	-	5x20	-
24	Chumphon	100.00	11.00	1.50	6	2x10	-	4x20	-
25	Chaing Mai	240.00	11.00	1.50	19	4x10	-	5x20	-
26	Mae Hong Son	170.00	11.00	1.50	7	2x10	5x30	-	-
27	Mae Hong Son	160.00	11.00	1.50	6	-	(2x20)+(4x30)	-	-
28	Maha Sarakham	140.00	11.00	1.50	7	-	7x20	-	-
29	Phrae	150.00	11.00	1.50	8	1x10	-	7x20	-
30	Phetchabun	100.00	11.00	1.50	5	-	-	5x20	-
31	Phetchabun	100.00	11.00	1.50	5	-	-	5x20	-
32	Phetchaburi	240.00	11.00	1.50	12	-	-	12x20	-
33	Phetchaburi	60.00	11.00	1.50	3	-	-	3x20	-
34	Phitsanulok	160.00	11.00	1.50	8	3x10	3x30	2x20	-
35	Phichit	170.00	11.00	1.50	7	2x10	5x30	-	-
36	Phrachin Buri	110.00	11.00	1.50	8	5x10	-	3x20	-
37	Phangnga	100.00	11.00	1.50	6	2x10	-	4x20	-
38	Prachuap Khiri Khan	90.00	11.00	1.50	4	-	(3x20)+(1x30)	-	-
39	Nan	150.00	11.00	1.50	7	1x10	2x30	4x20	-

Appendix Table A12 (cont'd)

No.	Province	project characteristic							
		Length (m.)	width (m.)	sidewalk (m.)	No. of span	R.C.Slab	I-Girder	box-Girder	plank-girder
40	Narathiwat	60.00	11.00	1.50	3	-	-	3x20	-
41	Nakhon Si Thammarat	100.00	11.00	1.50	5	-	-	5x20	-
42	Nakhon Ratchasima	110.00	11.00	1.50	6	1x10	5x20	-	-
43	Nakhon Phanom	210.00	11.00	1.50	10		(9x20)+(1x30)	-	-
44	Nakhon Nayok	80.00	11.00	1.50	5	2x10	-	3x20	-
45	Trang	90.00	11.00	1.50	5	1x10	-	4x20	-
46	Ubon Ratchathani	160.00	11.00	1.50	8	-	8x20	-	-
47	Lampang	160.00	11.00	1.50	10	4x10	-	6x20	-
48	Yala	50.00	11.00	1.50	3	2x10	1x30	-	-
49	Ratchaburi	190.00	11.00	1.50	14	7x10	7x20	-	-

Appendix Table A13 Construction cost of concrete bridge 2004

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
1	Roi Et	140.00	June	8,921,504.26	5,530,471.63	14,451,975.89	103,228.40
2	Samut Sakhon	120.00	June	7,251,393.94	6,916,255.57	14,167,649.51	118,063.75
3	Chiang Mai/Lamphun	140.00	June	10,068,266.12	8,969,392.43	19,037,658.55	135,983.28
4	Chiang Mai	70.00	June	3,292,311.24	4,885,788.68	8,178,099.92	116,830.00
5	Udon Thani	60.00	June	4,026,687.06	2,974,977.99	7,001,665.05	116,694.42
6	Phayao	80.00	June	5,757,298.71	4,128,859.36	9,886,158.07	123,576.98
7	Surin	120.00	June	7,496,448.57	5,925,326.02	13,421,774.59	111,848.12
8	Chiang Rai	110.00	June	4,771,704.90	2,629,188.05	7,400,892.95	67,280.85
9	Khon Kaen	100.00	June	6,105,938.64	5,443,089.43	11,549,028.07	115,490.28
10	Lampang	140.00	June	7,000,697.64	7,206,752.90	14,207,450.54	101,481.79
11	Phetchaburi	100.00	June	7,280,868.57	3,487,560.63	10,768,429.20	107,684.29
12	Saraburi	170.00	June	10,824,484.25	7,793,337.78	18,617,822.03	109,516.60
13	Kanchanaburi	160.00	June	10,666,122.78	10,512,554.96	21,178,677.74	132,366.74
14	Yala	50.00	June	3,046,314.11	1,912,698.83	4,959,012.94	99,180.26

Appendix Table A13 (cont'd)

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
15	Chachengtrao	80.00	July	4,384,033.81	4,563,050.70	8,947,084.51	111,838.56
16	Sing Buri	240.00	June	16,266,084.78	11,025,537.55	27,291,622.33	113,715.09
17	Patthani	80.00	August	4,139,670.11	3,679,824.97	7,819,495.08	97,743.69
18	Narathiwat	100.00	June	6,600,530.40	3,555,239.43	10,155,769.83	101,557.70
19	Satun	60.00	June	4,240,829.35	2,840,146.30	7,080,975.65	118,016.26
20	Trang	80.00	June	5,128,441.64	2,691,946.15	7,820,387.79	97,754.85
21	Chaiyaphum	150.00	June	9,336,340.67	5,996,823.12	15,333,163.79	102,221.09
22	Surat Thani	150.00	July	9,354,145.80	5,775,577.50	15,129,723.30	100,864.82
23	Si Sa Ket	150.00	June	9,353,688.35	5,986,255.49	15,339,943.84	102,266.29
24	Nakhon Si Thammarat	100.00	June	7,329,238.27	6,045,038.82	13,374,277.09	133,742.77
25	Krabi	60.00	June	4,748,395.85	2,306,099.83	7,054,495.68	117,574.93
26	Songkhla	80.00	June	5,991,886.80	6,363,949.68	12,355,836.48	154,447.96
27	Chumphon	100.00	June	6,372,637.57	4,572,916.28	10,945,553.85	109,455.54
28	Loei	130.00	June	7,374,127.87	5,559,428.26	12,933,556.13	99,488.89

Appendix Table A13 (cont'd)

No.	Province	Length (m.)	Date Contract Signed	Cost of Super-structure (Baht)	Cost of Sub-structure (Baht)	Total Cost (Baht)	Cost / Length (Baht/m.)
29	Nong Khai	110.00	June	7,474,345.06	9,091,720.64	16,566,065.70	150,600.60
30	Prachuap Khiri Khan	90.00	June	6,240,471.72	4,564,837.83	10,805,309.55	120,059.00
31	Phichit	170.00	June	10,383,526.93	10,932,111.68	21,315,638.61	125,386.11
32	Phetchabun	130.00	June	6,789,078.40	6,244,510.38	13,033,588.78	100,258.38
	AVERAGE						**113,006.82**

Appendix Table A14 Construction cost of concrete bridge 2004 (super - structure)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
1	140.00	-	-	6,207,810.00	1,407,907.20	580,520.64	595,624.30	129,942.12	8,921,804.26
2	120.00	-	-	3,695,021.96	2,336,453.92	513,931.75	579,130.76	126,855.54	7,251,393.94
3	140.00	-	-	8,791,173.66	-	599,593.26	556,294.71	121,204.49	10,068,266.12
4	70.00	-	-	-	2,591,955.36	306,283.44	273,471.40	120,601.05	3,292,311.24
5	60.00	-	3,406,296.96	-	-	253,479.60	245,054.70	121,855.80	4,026,687.06
6	80.00	-	-	4,978,268.48	-	347,098.99	313,955.33	117,975.91	5,757,298.71
7	120.00	-	-	4,969,544.00	1,408,841.60	497,919.36	497,352.45	122,791.16	7,496,448.57
8	110.00	-	-	-	3,742,091.45	471,689.13	439,286.43	118,637.89	4,771,704.90
9	100.00	-	-	3,733,647.00	1,411,294.40	416,863.50	421,128.80	123,004.94	6,105,938.64
10	140.00	-	5,833,169.97	-	-	545,664.94	501,884.90	119,977.83	7,000,697.64
11	100.00	-	-	6,241,721.14	-	426,817.44	487,303.21	125,026.78	7,280,868.57
12	170.00	-	6,210,469.21	-	2,993,702.40	749,121.25	731,245.39	139,945.99	10,824,484.25
13	160.00	-	9,175,994.37	-	-	676,592.13	682,036.10	131,500.19	10,666,122.78
14	50.00	-	2,152,712.81	-	405,593.88	202,306.50	170,153.25	115,547.66	3,046,314.11

Appendix Table A14 (cont'd)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
15	80.00	-	-	1,269,343.32	2,269,187.40	354,950.21	366,061.73	124,491.15	4,384,033.81
16	240.00	-	4,020,684.35	8,559,539.66	1,462,707.80	993,623.52	1,094,972.69	134,556.75	16,266,084.78
17	80.00	-	-	-	3,320,283.60	354,943.68	348,184.15	116,258.68	4,139,670.11
18	100.00	-	5,616,814.18	-	-	433,824.40	433,498.43	116,393.39	6,600,530.40
19	60.00	-	3,630,346.86	-	-	253,583.40	240,636.72	116,262.37	4,240,829.35
20	80.00	-	4,346,511.87	-	-	337,502.24	328,374.56	116,052.97	5,128,441.64
21	150.00	-	-	6,204,205.00	1,758,862.00	621,625.20	639,129.49	112,518.98	9,336,340.67
22	150.00	-	5,813,820.38	-	2,101,250.25	643,203.00	677,180.74	118,691.43	9,354,145.80
23	150.00	-	-	6,204,205.00	1,758,862.00	621,625.20	639,129.49	129,866.66	9,353,688.35
24	100.00	-	-	6,399,639.00	-	412,452.00	401,431.57	115,715.70	7,329,238.27
25	60.00	-	-	4,120,334.64	-	250,672.32	262,326.38	115,062.50	4,748,395.85
26	80.00	-	-	5,198,084.60	-	341,680.80	339,530.82	112,590.58	5,991,886.80
27	100.00	-	5,433,902.96	-	-	408,709.60	414,062.73	115,962.28	6,372,637.57
28	130.00	-	-	3,734,574.00	2,470,378.40	518,489.40	522,816.19	127,869.88	7,374,127.87

Appendix Table A14 (cont'd)

Project No.	Length (m.)	R.C.Slab (Baht)	I - girder (Baht)	Box - girder (Baht)	plank - girder (Baht)	sidewalk (Baht)	rail (Baht)	misscellaneous (Baht)	Total Cost (Baht)
29	110.00	-	6,429,443.18	-	-	463,424.50	470,977.72	110,499.66	7,474,345.06
30	90.00	-	4,148,181.98	-	1,146,706.63	193,403.35	664,221.33	87,958.44	6,240,471.72
31	170.00	-	7,847,633.69	-	1,061,336.02	638,690.85	704,171.87	131,694.50	10,383,526.93
32	130.00	-	-	3,051,290.68	2,581,777.66	502,991.94	525,678.08	127,340.04	6,789,078.40

Appendix Table A15 Construction cost of concrete bridge 2004 (sub - suructure)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
1	Roi Et	140.00	11.00	2,131,629.36	3,356,556.84	42,285.43	5,530,471.63
2	Samut Sakhon	120.00	11.00	3,882,895.46	2,991,045.24	42,314.87	6,916,255.57
3	Chiang Mai/Lamphun	140.00	11.00	4,812,413.62	4,115,781.11	41,197.70	8,969,392.43
4	Chiang Mai	70.00	11.00	2,016,551.33	2,826,296.00	42,941.35	4,885,788.68
5	Udon Thani	60.00	11.00	389,499.00	2,565,345.42	20,133.57	2,974,977.99
6	Phayao	80.00	11.00	1,738,315.28	2,346,738.98	43,805.10	4,128,859.36
7	Surin	120.00	11.00	1,845,486.00	4,036,235.89	43,604.13	5,925,326.02
8	Chiang Rai	110.00	11.00	1,278,239.01	1,332,849.75	18,099.29	2,629,188.05
9	Khon Kaen	100.00	11.00	2,424,961.44	2,974,447.94	43,680.05	5,443,089.43
10	Lampang	140.00	11.00	2,444,406.43	4,718,733.91	43,612.57	7,206,752.91
11	Phetchaburi	100.00	11.00	1,174,673.46	2,261,686.02	51,201.16	3,487,560.64
12	Saraburi	170.00	11.00	2,978,059.83	4,745,825.50	69,452.46	7,793,337.79
13	Kanchanaburi	160.00	11.00	6,356,369.70	4,088,946.06	67,239.21	10,512,554.97
14	Yala	50.00	11.00	824,400.21	1,067,136.14	21,162.49	1,912,698.84
15	Chachengtrao	80.00	11.00	2,917,498.35	1,600,751.01	44,801.35	4,563,050.71

Appendix Table A15 (cont'd)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
16	Sing Buri	240.00	11.00	4,684,790.79	6,271,720.55	69,026.21	11,025,537.55
17	Patthani	80.00	11.00	2,320,239.53	1,338,559.41	21,026.03	3,679,824.97
18	Narathiwat	100.00	11.00	1,951,240.36	1,583,095.52	20,903.55	3,555,239.43
19	Satun	60.00	11.00	1,377,803.14	1,441,272.28	21,070.88	2,840,146.30
20	Trang	80.00	11.00	662,860.25	2,008,052.98	21,032.93	2,691,946.16
21	Chaiyaphum	150.00	11.00	2,436,626.22	3,523,451.14	36,745.76	5,996,823.12
22	Surat Thani	150.00	11.00	2,226,156.90	3,528,642.98	20,777.63	5,775,577.51
23	Si Sa Ket	150.00	11.00	2,240,883.56	3,701,681.69	43,687.24	5,986,252.49
24	Nakhon Si Thammarat	100.00	11.00	4,076,280.00	1,947,955.32	20,803.50	6,045,038.82
25	Krabi	60.00	11.00	1,164,184.80	1,120,842.43	21,072.60	2,306,099.83
26	Songkhla	80.00	11.00	4,370,980.59	1,972,156.97	20,812.13	6,363,949.69
27	Chumphon	100.00	11.00	683,198.00	3,868,859.58	20,858.70	4,572,916.28
28	Loei	130.00	11.00	2,164,626.77	3,344,903.23	49,898.26	5,559,428.26
29	Nong Khai	110.00	11.00	5,967,655.71	3,055,833.19	68,231.73	9,091,720.63
30	Prachuap Khiri Khan	90.00	11.00	2,452,911.47	2,037,617.29	74,309.07	4,564,837.83

Appendix Table A15 (cont'd)

No.	Province	Length (m.)	width (m.)	pile (Baht)	pier (Baht)	miscellaneous (Baht)	Total Cost (Baht)
31	Phichit	170.00	11.00	4,600,691.16	6,261,914.73	69,505.79	10,932,111.68
32	Phetchabun	130.00	11.00	2,225,329.28	3,968,047.29	51,133.82	6,244,510.39

Appendix Table A16 Project characteristic concrete bridge 2004

No.	Province	project characteristic							
		Length (m.)	width (m.)	sidewalk (m.)	No. of span	R.C.Slab	I-Girder	box-Girder	plank-girder
1	Roi Et	140.00	11.00	1.50	9	-	-	5x20	4x10
2	Samut Sakhon	120.00	11.00	1.50	9	-	-	3x20	6x10
3	Chiang Mai/Lamphun	140.00	11.00	1.50	7	-	-	7x20	-
4	Chiang Mai	70.00	11.00	1.50	7	-	-	-	7x10
5	Udon Thani	60.00	11.00	1.50	3	-	3x20	-	-
6	Phayao	80.00	11.00	1.50	4	-	-	4x20	-
7	Surin	120.00	11.00	1.50	8	-	-	4x20	4x10
8	Chiang Rai	110.00	11.00	1.50	11	-	-	-	11x10
9	Khon Kaen	100.00	11.00	1.50	7	-	-	3x20	4x10
10	Lampang	140.00	11.00	1.50	7	-	7x20	-	-
11	Phetchaburi	100.00	11.00	1.50	5	-	-	5x20	-
12	Saraburi	170.00	11.00	1.50	11	-	3x30	-	8x10
13	Kanchanaburi	160.00	11.00	1.50	7	-	(5x20)+(2x30)	-	-
14	Yala	50.00	11.00	1.50	3	-	2x20	-	1x10
15	Chachengtrao	80.00	11.00	1.50	7	-	-	1x20	6x10
16	Sing Buri	240.00	11.00	1.50	11	-	2x30	7x20	4x10
17	Patthani	80.00	11.00	1.50	8	-	-	-	8x10
18	Narathiwat	100.00	11.00	1.50	5	-	5x20	-	-
19	Satun	60.00	11.00	1.50	3	-	3x20	-	-
20	Trang	80.00	11.00	1.50	4	-	4x20	-	-

Appendix Table A16 (cont'd)

No.	Province	project characteristic							
		Length (m.)	width (m.)	sidewalk (m.)	No. of span	R.C.Slab	I-Girder	box-Girder	plank-girder
21	Chaiyaphum	150.00	11.00	1.50	10	-	-	5x20	5x10
22	Surat Thani	150.00	11.00	1.50	10	-	5x20	-	5x11
23	Si Sa Ket	150.00	11.00	1.50	10	-	-	5x20	5x12
24	Nakhon Si Thammarat	100.00	11.00	1.50	5	-	-	5x20	-
25	Krabi	60.00	11.00	1.50	3	-	-	3x20	-
26	Songkhla	80.00	11.00	1.50	4	-	-	4x20	-
27	Chumphon	100.00	11.00	1.50	5	-	5x20	-	-
28	Loei	130.00	11.00	1.50	10	-	-	3x20	7x10
29	Nong Khai	110.00	11.00	1.50	5	-	(4x20)+(1x30)	-	-
30	Prachuap Khiri Khan	90.00	11.00	1.50	5	-	2x30	-	3x10
31	Phichit	170.00	11.00	1.50	9	-	(4x20)+(2x30)	-	3x10
32	Phetchabun	130.00	11.00	1.50	10	-	3x20	-	7x10

APPENDIX B

Appendix Table B1 Quantity of material of concrete bridge

No.	Province	Bridge length	Quantity of materials				Quantity of materials/m.^{2}		
			concrete	formwork	rebar	pc wire/ strand	concrete	formwork	rebars & pc wire/ strand
		(m.)	(m.^{3})	(m.^{2})	(kg.)	(kg.)	(m.^{3}/m.^{2})	(m.^{2}/m.^{2})	(kg./m.^{2})
1	Roi Et	140	1,575.62	8,785.49	175,434.00	24,468	1.02	5.70	113.92
2	Samut Sakhon	120	1,489.23	8,336.53	200,914.00	21,199	1.13	6.32	152.21
3	Chiang Mai/Lamphun	140	1,803.85	11,036.01	273,537.00	24,115	1.17	7.17	177.62
4	Chiang Mai	70	867.25	3,712.73	89,466.00	12,675	1.13	4.82	116.19
5	Phayao	80	955.45	5,537.59	114,960.00	13,780	1.09	6.29	130.64
6	Surin	120	1,317.52	7,366.05	154,158.00	21,023	1.00	5.58	116.79
7	Khon Kaen	100	1,197.11	6,525.44	142,962.00	17,578	1.09	5.93	129.97
8	Lampang	140	1,438.38	7,445.14	285,765.00	17,632	0.93	4.83	185.56
9	Phetchaburi	100	1,095.30	6,359.74	122,218.00	17,225	1.00	5.78	111.11
10	Kanchanaburi	160	1,505.07	7,857.17	293,567.00	22,280	0.86	4.46	166.80
11	Yala	50	513.49	2,611.65	82,503.00	6,849	0.93	4.75	150.01
12	Sing Buri	240	2,848.55	15,005.16	386,412.00	41,044	1.08	5.68	146.37
13	Patthani	80	753.90	3,921.26	81,175.00	14,486	0.86	4.46	92.24

Appendix Table B1 (cont'd)

No.	Province	Bridge length	Quantity of materials				Quantity of materials/m.^{2}		
			concrete	formwork	rebar	pc wire/ strand	concrete	formwork	rebars & pc wire/ strand
		(m.)	(m.^{3})	(m.^{2})	(kg.)	(kg.)	(m.^{3}/m.^{2})	(m.^{2}/m.^{2})	(kg./m.^{2})
14	Narathiwat	100	998.92	6,670.12	224,949.00	24,215	0.91	6.06	204.50
15	Kanchanaburi	280	3,039.78	16,629.19	677,831.00	39,523	0.99	5.40	220.08
16	Ratchaburi	240	2,814.88	14,776.59	569,246.00	34,485	1.07	5.60	215.62
17	Phetchabun	100	950.36	5,091.69	187,791.00	12,595	0.86	4.63	170.72
18	Ranong	50	543.98	2,445.46	73,955.00	8,465	0.99	4.45	134.46
19	Prachuap Khiri Khan	140	1,636.59	9,366.91	205,163.00	22,480	1.06	6.08	133.22
20	Chaiyaphum	80	985.22	6,009.11	139,930.00	13,780	1.12	6.83	159.01
21	Samut Sakhon	120	1,383.94	7,956.24	188,412.00	21,199	1.05	6.03	142.74
22	Ratchaburi	50	479.28	2,488.81	50,162.00	2,489	0.87	4.53	91.20
23	Phetchabun	100	899.90	4,829.24	174,604.00	8,465	0.82	4.39	158.73
24	Prachuap Khiri Khan	90	830.66	3,692.31	143,550.00	10,470	0.84	3.73	145.00
25	Surat Thani	150	1,347.34	5,667.90	218,646.00	21,648	0.82	3.44	132.51
26	Nakhon Si Thammarat	100	1,314.08	7,882.82	186,669.00	17,300	1.19	7.17	185.43

Appendix Table B1 (cont'd)

No.	Province	Bridge length	Quantity of materials				Quantity of materials/m.^{2}		
			concrete	formwork	rebar	pc wire/ strand	concrete	Formwork	rebars & pc wire/ strand
		(m.)	(m.^{3})	(m.^{2})	(kg.)	(kg.)	(m.^{3}/m.^{2})	(m.^{2}/m.^{2})	(kg./m.^{2})
27	Satun	60	629.56	3,666.34	129,880.00	7,557	0.95	5.56	196.79
28	Narathiwat	350	7,584.12	24,246.38	808,296.00	58,292	1.99	6.30	225.09
29	Nakhon Si Thammarat	100	1,086.84	6,460.44	234,724.00	12,595	0.99	5.87	213.39
30	Trang	80	682.29	3,870.96	136,842.00	10,076	0.78	4.40	155.50
31	Phitsanulok	120	919.10	4,174.94	127,080.00	7,557	0.70	3.16	96.27
32	Phachin Buri	120	1,477.47	8,087.49	168,738.00	20,670	1.12	6.13	127.83
33	Chai Nat	60	787.52	4,410.10	77,304.40	10,335	1.19	6.68	117.13
34	Si Sa Ket	150	1,026.27	6,243.25	181,692.00	21,648	0.62	3.78	110.12
35	Chanthaburi	100	1,203.40	6,212.94	134,442.00	17,225	1.09	5.65	122.22
36	Surin	200	2,394.78	15,038.08	266,533.00	34,450	1.09	6.84	121.15
37	Sa Kaeo	60	728.20	4,261.80	82,366.00	10,335	1.10	6.46	124.80
38	Uthai Thani	90	1,125.96	5,313.46	107,883.00	15,767	1.14	5.37	108.97
39	Nakhon Phathom	110	1,057.80	6,135.72	89,408.00	19,212	0.87	5.07	73.89

Appendix Table B1 (cont'd)

No.	Province	Bridge length	Quantity of materials				Quantity of materials/m.^{2}		
			concrete	formwork	rebar	pc wire/ strand	concrete	Formwork	rebars & pc wire/ strand
		(m.)	(m.^{3})	(m.^{2})	(kg.)	(kg.)	(m.^{3}/m.^{2})	(m.^{2}/m.^{2})	(kg./m.^{2})
40	Lop Buri	160	1,951.45	9,539.80	209,421.00	20,670	1.11	5.42	130.73
41	Chai Nat	80	1,008.02	4,825.78	97,633.00	13,956	1.15	5.48	110.95
42	Phichit	140	1,692.65	8,991.42	183,660.00	24,115	1.10	5.84	119.26
43	Phichit	170	1,894.09	7,442.18	195,152.00	15,508	1.01	3.98	104.36
44	Phetchabun	130	1,334.46	5,201.80	202,287.00	20,232	0.93	3.64	141.46
45	Sukhothai	170	1,869.70	8,199.77	273,390.00	24,167	1.00	4.38	146.20
46	Phitsanulok	120	1,363.04	5,533.46	168,243.00	18,421	1.03	4.19	127.46
47	Sukhothai	60	715.18	1,666.74	79,300.00	10,335	1.08	2.53	120.15
48	Sukhothai	180	1,826.64	7,709.73	351,960.00	26,929	0.92	3.89	177.76
49	Chiang Mai	60	700.01	3,521.77	78,066.00	10,542	1.06	5.34	134.25
50	Lampang	60	713.76	1,544.12	78,838.00	10,335	1.08	2.34	119.45
51	Chiang Mai	160	1,905.82	9,907.45	190,822.00	27,560	1.08	5.63	108.42
52	Chiang Rai	100	1,298.82	5,971.54	130,967.00	17,620	1.18	5.34	129.62

Appendix Table B1 (cont'd)

No.	Province	Bridge length	Quantity of materials				Quantity of materials/m.^{2}		
			concrete	formwork	rebar	pc wire/ strand	concrete	Formwork	rebars & pc wire/ strand
		(m.)	(m.^{3})	(m.^{2})	(kg.)	(kg.)	(m.^{3}/m.^{2})	(m.^{2}/m.^{2})	(kg./m.^{2})
53	Lampang	100	1,176.67	6,230.94	127,296.00	17,225	1.07	5.66	115.72
54	Mae Hong Son	160	1,825.50	9,490.53	187,802.00	27,560	1.04	5.39	106.71
55	Phitsanulok	120	1,295.80	7,864.90	138,053.00	20,670	0.98	5.96	104.59
56	Phetchabun	100	1,272.56	9,124.81	127,473.00	17,225	1.16	8.30	115.88
57	Phetchabun	100	1,114.48	7,472.64	130,994.00	17,225	1.01	6.79	119.09
58	Chiang Mai	140	1,557.34	10,380.64	177,482.00	24,115	1.01	6.74	115.25
59	Lampang	120	1,404.39	8,894.04	169,347.00	20,670	1.06	6.74	128.29
60	Uttaradit	80	1,123.39	5,651.08	104,660.00	13,780	1.28	6.42	118.93
61	Phayao	80	873.42	4,852.25	96,855.00	13,780	0.99	5.51	110.06
62	Lampang	140	1,385.12	6,512.86	256,307.00	13,780	0.90	4.23	166.43
63	Chiang Mai	140	1,455.90	7,019.48	258,450.00	13,780	0.95	4.56	167.82
64	Phrae	150	1,632.65	9,600.31	249,562.00	25,925	0.99	5.82	151.25
65	Nan	130	1,629.76	6,886.54	234,156.00	21,832	1.14	4.82	163.75

Appendix Table B1 (cont'd)

No.	Province	Bridge length	Quantity of materials				Quantity of materials/m.^{2}		
			concrete	formwork	rebar	pc wire/ strand	concrete	Formwork	rebars & pc wire/ strand
		(m.)	(m.^{3})	(m.^{2})	(kg.)	(kg.)	(m.^{3}/m.^{2})	(m.^{2}/m.^{2})	(kg./m.^{2})
66	Phrachin Buri	120	1,574.53	7,328.17	175,315.00	20,846	1.19	5.55	132.81
67	Phra Nakhon Si Ayutthaya	230	2,421.62	11,278.90	294,110.00	28,309	0.96	4.46	116.25
68	Nakhon Nayok	70	689.06	3,252.56	41,761.00	12,675	0.89	4.22	54.24
69	Nakhon Nayok	60	537.44	2,511.40	33,947.00	10,865	0.81	3.81	51.43
70	Samut Prakan	70	932.89	4,833.94	81,241.00	12,146	1.21	6.28	105.51
71	Chanthaburi	110	1,210.41	6,267.79	125,764.00	19,212	1.00	5.18	103.94
72	Chanthaburi	80	886.80	4,473.54	88,908.00	13,956	1.01	5.08	101.03
73	Chachoengsao	70	1,008.56	2,837.50	38,345.00	12,675	1.31	3.69	49.80
74	Phrachin Buri	120	1,479.45	7,293.43	159,973.00	20,846	1.12	5.53	121.19
75	Chachoengsao	80	836.38	4,197.50	64,229.00	14,310	0.95	4.77	72.99
76	Phrachin Buri	100	1,285.19	7,086.34	127,543.00	17,225	1.17	6.44	115.95
77	Buri Ram	130	1,062.40	7,639.19	158,293.00	22,834	0.74	5.34	110.69
78	Krabi	80	965.70	6,961.31	121,718.00	13,780	1.10	7.91	138.32

Appendix Table B1 (cont'd)

No.	Province	Bridge length	Quantity of materials				Quantity of materials/m.^{2}		
			concrete	formwork	rebar	pc wire/ strand	concrete	Formwork	rebars & pc wire/ strand
		(m.)	(m.^{3})	(m.^{2})	(kg.)	(kg.)	(m.^{3}/m.^{2})	(m.^{2}/m.^{2})	(kg./m.^{2})
79	Songkhla	120	1,180.56	5,494.68	293,190.00	15,113	0.89	4.16	222.11
80	Phangnga	80	1,016.43	5,400.62	106,904.00	13,956	1.16	6.14	121.48
81	Chumphon	100	1,206.41	7,020.54	161,296.00	17,225	1.10	6.38	146.63
82	Krabi	60	735.22	4,222.24	95,179.00	10,335	1.11	6.40	144.21
83	Chumphon	100	1,091.55	4,482.91	201,688.00	12,595	0.99	4.08	183.35
84	Patthalung	80	817.32	4,832.88	96,097.00	13,780	0.93	5.49	109.20
85	Yala	150	1,626.92	8,901.93	361,862.00	19,956	0.99	5.40	219.31
86	Narathiwat	100	982.60	5,170.92	196,885.00	12,595	0.89	4.70	178.99
87	Trang	80	788.78	3,639.81	152,107.00	10,076	0.90	4.14	172.85
88	Phetchaburi	60	745.48	4,377.54	105,723.00	10,335	1.13	6.63	160.19
89	Narathiwat	240	2,827.52	16,934.52	397,526.00	41,339	1.07	6.41	150.58
90	Prachuap Khiri Khan	90	892.14	4,725.71	189,046.00	12,400	0.90	4.77	190.96
91	Trang	90	1,098.91	6,156.73	137,901.00	15,591	1.11	6.22	139.29

Appendix Table B1 (cont'd)

No.	Province	Bridge length	Quantity of materials				Quantity of materials/m.^{2}		
			concrete	formwork	rebar	pc wire/ strand	concrete	Formwork	Rebars & pc wire/ strand
		(m.)	(m.^{3})	(m.^{2})	(kg.)	(kg.)	(m.^{3}/m.^{2})	(m.^{2}/m.^{2})	(kg./m.^{2})
92	Songkhla	80	1,127.24	6,807.44	168,712.00	13,780	1.28	7.74	191.72
93	Satun	120	1,406.14	6,851.11	291,893.00	22,086	1.07	5.19	221.13
94	Patthalung	120	1,092.40	5,321.86	217,700.00	15,113	0.83	4.03	164.92
95	Krabi	80	1,012.44	5,179.20	118,866.00	10,076	1.15	5.89	135.08
96	Chumphon	120	1,222.37	6,205.76	263,213.59	20,670	0.93	4.70	199.40
97	Songkhla	160	2,177.89	13,122.56	337,877.00	27,560	1.24	7.46	191.98
98	Udon Thani	60	741.76	3,794.96	79,889.00	10,335	1.12	5.75	121.04
99	Nong Khai	110	1,204.16	6,130.72	157,665.00	18,623	1.00	5.07	130.30
100	Loei	130	1,421.59	7,342.81	138,823.00	23,010	0.99	5.13	97.08
						average	**1.03**	**5.33**	**151.95**
						std	**0.17**	**1.21**	**38.89**
						min	**0.24**	**0.76**	**49.80**
						max	**1.31**	**8.30**	**273.86**

Appendix Table B2 Quantity of material of concrete bridge (super-structure)

No.	Province	Bridge Length (m.)	Quantity of materials			
			concrete ($m.^3$)	formwork ($m.^2$)	rebar (kg.)	pc wire/strand (kg.)
1	Roi Et	140	929	5,815	90,315	24,468
2	Samut Sakhon	120	761	4,369	67,704	21,199
3	Chiang Mai/Lamphun	140	985	6,771	105,419	24,115
4	Chiang Mai	70	369	1,711	26,279	12,675
5	Phayao	80	563	3,869	60,236	13,780
6	Surin	120	789	4,847	75,256	21,023
7	Khon Kaen	100	648	3,880	60,196	17,578
8	Lampang	140	726	4,693	181,779	17,632
9	Phetchaburi	100	703	4,837	75,299	17,225
10	Kanchanaburi	160	870	5,162	207,506	22,280
11	Yala	50	264	1,585	55,691	6,849
12	Sing Buri	240	1,562	9,559	198,099	41,044
13	Patthani	80	452	1,956	30,033	14,486
14	Narathiwat	100	519	4,525	194,159	24,215
15	Kanchanaburi	280	1,532	8,984	363,074	39,523

Appendix Table B2 (cont'd)

No.	Province	Bridge Length (m.)	Quantity of materials			
			concrete ($m.^3$)	formwork ($m.^2$)	rebar (kg.)	pc wire/strand (kg.)
16	Ratchaburi	240	1,324	7,643	311,138	34,485
17	Phetchabun	100	519	3,352	129,842	12,595
18	Ranong	50	288	1,394	46,340	8,465
19	Prachuap Khiri Khan	140	900	6,048	94,113	22,480
20	Chaiyaphum	80	563	3,869	60,239	13,780
21	Samut Sakhon	120	761	4,369	67,704	21,199
22	Ratchaburi	50	254	1,456	22,568	7,066
23	Phetchabun	100	519	3,352	129,842	8,465
24	Prachuap Khiri Khan	90	377	1,467	63,199	10,470
25	Surat Thani	150	801	4,575	148,612	21,648
26	Nakhon Si Thammarat	100	703	4,837	75,299	17,300
27	Satun	60	311	2,011	77,905	7,557
28	Narathiwat	350	2,185	12,628	369,690	58,192
29	Nakhon Si Thammarat	100	519	3,352	129,842	12,595
30	Trang	80	415	2,682	103,874	10,076

Appendix Table B2 (cont'd)

No.	Province	Bridge Length (m.)	Quantity of materials			
			concrete ($m.^3$)	formwork ($m.^2$)	rebar (kg.)	pc wire/strand (kg.)
31	Phitsanulok	120	311	2,011	77,905	7,557
32	Phachin Buri	120	844	5,804	90,359	20,670
33	Chai Nat	60	422	2,902	45,179	10,335
34	Si Sa Ket	150	801	4,575	148,612	21,648
35	Chanthaburi	100	703	4,837	75,299	17,225
36	Surin	200	1,407	9,673	150,598	34,450
37	Sa Kaeo	60	422	2,902	45,179	10,335
38	Uthai Thani	90	592	3,635	56,442	15,767
39	Nakhon Phathom	110	732	4,603	71,501	19,212
40	Lop Buri	160	1,100	6,500	94,072	20,670
41	Chai Nat	80	535	3,391	52,688	13,956
42	Phichit	140	985	6,771	105,419	24,115
43	Phichit	170	584	3,415	71,501	15,508
44	Phetchabun	130	707	3,723	130,152	20,232
45	Sukhothai	170	905	5,245	174,581	24,167

Appendix Table B2 (cont'd)

No.	Province	Bridge length (m.)	Quantity of materials			
			concrete ($m.^3$)	formwork ($m.^2$)	rebar (kg.)	pc wire/strand (kg.)
46	Phitsanulok	120	650	3,478	100,430	18,421
47	Sukhothai	60	422	733	45,179	10,335
48	Sukhothai	180	1,013	5,631	233,232	26,929
49	Chiang Mai	60	331	2,424	37,628	10,542
50	Lampang	60	422	733	45,179	10,335
51	Chiang Mai	160	1,125	7,739	120,478	27,560
52	Chiang Rai	100	648	3,880	60,196	11,620
53	Lampang	100	703	4,837	75,299	17,225
54	Mae Hong Son	160	1,125	7,739	120,478	27,560
55	Phitsanulok	120	844	5,804	90,359	20,670
56	Phetchabun	100	703	4,837	75,299	17,225
57	Phetchabun	100	703	4,837	75,299	17,225
58	Chiang Mai	140	985	6,771	105,419	24,115
59	Lampang	120	844	5,804	90,359	20,670
60	Uttaradit	80	563	3,869	60,239	13,780

Appendix Table B2 (cont'd)

No.	Province	Bridge length (m.)	Quantity of materials			
			concrete ($m.^3$)	formwork ($m.^2$)	rebar (kg.)	pc wire/strand (kg.)
61	Phayao	80	563	3,869	60,239	13,780
62	Lampang	140	726	4,693	181,779	13,780
63	Chiang Mai	140	726	4,693	181,779	13,780
64	Phrae	150	783	7,016	109,173	25,925
65	Nan	130	829	4,956	126,597	21,832
66	Phrachin Buri	120	816	5,326	82,807	20,846
67	Phra Nakhon Si Ayutthaya	230	1,089	6,584	176,735	28,309
68	Nakhon Nayok	70	396	1,711	26,279	12,675
69	Nakhon Nayok	60	339	1,467	22,525	10,865
70	Samut Prakan	70	479	3,146	48,933	12,146
71	Chanthaburi	110	732	4,603	71,501	19,212
72	Chanthaburi	80	535	3,391	52,688	13,956
73	Chachoengsao	70	796	1,711	26,279	12,675
74	Phrachin Buri	120	816	5,326	82,807	20,846
75	Chachoengsao	80	423	2,434	37,584	14,310

Appendix Table B2 (cont'd)

No.	Province	Bridge length (m.)	Quantity of materials			
			concrete ($m.^3$)	formwork ($m.^2$)	rebar (kg.)	pc wire/strand (kg.)
76	Phrachin Buri	100	703	4,837	75,299	17,225
77	Buri Ram	130	287	5,092	79,010	22,834
78	Krabi	80	563	3,869	60,236	13,780
79	Songkhla	120	622	4,023	155,810	15,113
80	Phangnga	80	535	3,391	52,688	13,956
81	Chumphon	100	703	4,837	75,299	17,225
82	Krabi	60	422	2,902	45,179	10,335
83	Chumphon	100	519	3,352	129,842	12,595
84	Patthalung	80	563	3,869	60,239	13,780
85	Yala	150	798	4,928	194,642	19,956
86	Narathiwat	100	519	3,352	129,842	12,595
87	Trang	80	415	2,682	103,874	10,076
88	Phetchaburi	60	422	2,902	45,179	10,335
89	Narathiwat	240	1,688	11,608	180,717	41,339
90	Prachuap Khiri Khan	90	487	2,916	116,737	12,400

Appendix Table B2 (cont'd)

No.	Province	Bridge length (m.)	Quantity of materials			
			concrete ($m.^3$)	formwork ($m.^2$)	rebar (kg.)	pc wire/strand (kg.)
91	Trang	90	619	4,114	63,993	15,591
92	Songkhla	80	563	3,869	60,239	13,780
93	Satun	120	838	4,726	194,401	22,086
94	Patthalung	120	622	4,023	155,810	15,113
95	Krabi	80	563	3,869	60,239	10,076
96	Chumphon	120	622	4,023	155,810	20,670
97	Songkhla	160	1,125	7,739	120,478	27,560
98	Udon Thani	60	422	2,902	45,179	10,335
99	Nong Khai	110	738	4,774	99,071	18,623
100	Loei	130	818	4,613	71,458	23,010

Appendix Table B3 Quantity of material of concrete bridge (sub-structure)

No.	Province	Bridge Length	Quantity of materials					
			pile			pier		
			concrete	formwork	rebar	concrete	formwork	rebar
		(m.)	$m.^3$	$m.^2$	kg.	$m.^3$	$m.^2$	kg.
1	Roi Et	140	195.84	1,490.56	29,294	450.78	1,480.37	55,825
2	Samut Sakhon	120	394.24	2,974.72	97,182	333.99	992.81	36,028
3	Chiang Mai/Lamphun	140	364.80	2,760.32	91,538	454.05	1,504.69	76,580
4	Chiang Mai	70	134.40	1,027.20	21,015	363.85	974.53	42,172
5	Phayao	80	110.40	842.72	17,029	282.05	825.87	37,695
6	Surin	120	163.84	1,249.28	25,018	361.68	1,269.77	53,884
7	Khon Kaen	100	220.48	1,670.56	31,409	328.63	974.88	51,357
8	Lampang	140	218.88	1,665.92	32,740	493.50	1,086.22	71,246
9	Phetchaburi	100	122.88	939.96	18,763	269.42	582.78	28,156
10	Kanchanaburi	160	194.56	1,479.04	28,746	440.51	1,216.13	57,315
11	Yala	50	80.64	613.76	12,062	168.85	412.89	14,750
12	Sing Buri	240	515.84	3,908.48	73,484	770.71	1,537.68	114,829
13	Patthani	80	167.04	1,262.08	41,525	134.86	703.18	9,617
14	Narathiwat	100	168.00	1,276.00	24,569	311.92	869.12	6,221

Appendix Table B3 (cont'd)

No.	Province	Bridge Length	Quantity of materials					
			pile			pier		
			concrete	formwork	rebar	concrete	formwork	rebar
		(m.)	$m.^3$	$m.^2$	kg.	$m.^3$	$m.^2$	kg.
15	Kanchanaburi	280	771.00	6,272.00	185,799	736.78	1,373.19	128,958
16	Ratchaburi	240	893.44	5,852.32	179,077	597.44	1,281.27	79,031
17	Phetchabun	100	150.70	1,175.32	22,654	280.66	564.37	35,295
18	Ranong	50	69.12	569.52	11,388	186.86	481.94	16,227
19	Prachuap Khiri Khan	140	300.72	2,455.88	43,979	435.84	863.03	67,071
20	Chaiyaphum	80	200.64	1,630.96	50,086	221.58	509.15	29,605
21	Samut Sakhon	120	371.20	656.84	91,711	251.74	2,930.40	28,997
22	Ratchaburi	50	82.88	675.92	12,324	142.40	356.89	15,270
23	Phetchabun	100	111.48	912.20	17,284	269.42	565.04	27,478
24	Prachuap Khiri Khan	90	217.02	1,765.94	48,487	236.64	459.37	31,864
25	Surat Thani	150	198.18	489.36	29,966	348.16	603.54	40,068
26	Nakhon Si Thammarat	100	343.00	2,480.00	84,708	267.78	560.22	26,662
27	Satun	60	142.05	1,150.90	32,360	176.51	504.44	19,615
28	Narathiwat	350	1,231.44	9,974.00	302,876	850.70	1,644.38	99,030

Appendix Table B3 (cont'd)

No.	Province	Bridge length	Quantity of materials					
			pile			pier		
			concrete	formwork	rebar	concrete	formwork	rebar
		(m.)	$m.^3$	$m.^2$	kg.	$m.^3$	$m.^2$	kg.
29	Nakhon Si Thammarat	100	302.08	2,451.52	78,942	265.76	656.92	25,940
30	Trang	80	93.81	765.82	13,812	173.48	423.14	19,156
31	Phitsanulok	120	256.32	1,244.16	13,902	351.78	919.78	35,273
32	Phachin Buri	120	280.80	1,465.20	16,751	352.67	818.29	61,628
33	Chai Nat	60	190.80	990.60	9,158	174.72	517.50	22,967
34	Si Sa Ket	150	20.79	111.93	2,493	204.48	1,556.32	30,587
35	Chanthaburi	100	159.36	841.92	12,398	341.04	534.02	46,745
36	Surin	200	391.68	4,277.88	31,502	596.10	1,087.20	84,433
37	Sa Kaeo	60	115.20	864.00	9,265	191.00	495.80	27,922
38	Uthai Thani	90	210.08	1,031.68	10,654	323.88	646.78	40,787
39	Nakhon Phathom	110	235.20	1,142.40	8,564	90.60	390.32	9,343
40	Lop Buri	160	290.00	2,497.60	42,460	561.45	542.20	72,890
41	Chai Nat	80	185.84	912.64	9,424	287.18	522.14	35,521
42	Phichit	140	251.60	1,240.32	13,593	456.05	980.10	64,648

Appendix Table B3 (cont'd)

No.	Province	Bridge length	Quantity of materials					
			pile			pier		
			concrete	formwork	rebar	concrete	formwork	rebar
		(m.)	$m.^3$	$m.^2$	kg.	$m.^3$	$m.^2$	kg.
43	Phichit	170	549.12	2,672.64	22,055	760.97	1,354.54	101,596
44	Phetchabun	130	111.74	556.48	7,029	515.72	922.32	65,106
45	Sukhothai	170	339.36	1,666.56	17,210	625.34	1,288.21	81,599
46	Phitsanulok	120	251.60	1,240.32	13,593	461.44	815.14	54,220
47	Sukhothai	60	100.80	499.20	5,848	192.38	434.54	28,273
48	Sukhothai	180	202.96	1,018.24	30,265	610.68	1,060.49	88,463
49	Chiang Mai	60	80.60	730.00	12,680	288.21	368.15	27,758
50	Lampang	60	99.60	489.60	7,749	192.16	321.52	25,910
51	Chiang Mai	160	288.96	1,431.04	7,621	491.86	737.41	62,723
52	Chiang Rai	100	240.00	1,171.20	16,124	410.76	920.42	54,646
53	Lampang	100	166.00	877.00	12,915	307.67	516.94	39,082
54	Mae Hong Son	160	181.44	965.52	4,786	519.06	786.01	62,538
55	Phitsanulok	120	175.16	1,396.64	14,384	276.64	664.26	33,310
56	Phetchabun	100	350.70	3,629.85	16,570	218.86	657.96	35,604

Appendix Table B3 (cont'd)

No.	Province	Bridge length	Quantity of materials					
			pile			pier		
			concrete	formwork	rebar	concrete	formwork	rebar
		(m.)	$m.^3$	$m.^2$	kg.	$m.^3$	$m.^2$	kg.
57	Phetchabun	100	190.32	1,985.36	13,919	221.16	650.28	41,776
58	Chiang Mai	140	263.52	2,748.96	19,273	308.82	860.68	52,790
59	Lampang	120	212.48	2,223.36	16,791	347.91	866.68	62,197
60	Uttaradit	80	276.92	1,339.52	14,079	283.47	442.56	30,342
61	Phayao	80	123.28	635.72	13,941	187.14	347.53	22,675
62	Lampang	140	214.32	1,136.96	19,331	444.80	682.90	55,197
63	Chiang Mai	140	312.48	1,634.40	20,039	417.42	692.08	56,632
64	Phrae	150	292.32	1,447.68	16,958	557.33	1,136.63	123,431
65	Nan	130	184.08	923.52	19,441	616.68	1,007.02	88,118
66	Phrachin Buri	120	208.38	1,037.76	13,107	550.15	1,018.41	79,401
67	Phra Nakhon Si Ayutthaya	230	740.08	3,600.64	27,805	592.54	1,094.26	89,570
68	Nakhon Nayok	70	217.62	1,054.08	7,143	75.44	487.48	8,339
69	Nakhon Nayok	60	141.12	685.44	5,138	57.32	358.96	6,284
70	Samut Prakan	70	252.00	1,219.20	8,086	201.89	468.74	24,222

Appendix Table B3 (cont'd)

No.	Province	Bridge length	Quantity of materials					
			pile			pier		
			concrete	formwork	rebar	concrete	formwork	rebar
		(m.)	$m.^3$	$m.^2$	kg.	$m.^3$	$m.^2$	kg.
71	Chanthaburi	110	166.10	827.20	10,448	312.31	837.59	43,815
72	Chanthaburi	80	114.76	571.52	7,218	237.04	511.02	29,002
73	Chachoengsao	70	153.12	744.96	5,753	59.44	381.54	6,313
74	Phrachin Buri	120	208.38	1,037.76	13,107	455.07	929.67	64,059
75	Chachoengsao	80	262.48	1,272.96	8,826	150.90	490.54	17,819
76	Phrachin Buri	100	308.04	1,501.44	11,971	274.15	747.90	40,273
77	Buri Ram	130	248.90	1,404.48	15,392	526.50	1,142.71	63,891
78	Krabi	80	155.52	1,268.16	32,597	247.18	1,824.15	28,885
79	Songkhla	120	365.50	741.10	90,562	193.06	730.58	46,818
80	Phangnga	80	168.32	1,372.72	27,018	313.11	636.90	27,198
81	Chumphon	100	212.38	1,609.84	42,983	291.03	573.70	43,014
82	Krabi	60	114.00	865.44	22,513	199.22	454.80	27,487
83	Chumphon	100	40.00	305.20	6,486	532.55	825.71	65,360
84	Patthalung	80	72.80	555.32	11,369	181.52	408.56	24,489

Appendix Table B3 (cont'd)

No.	Province	Bridge length	Quantity of materials					
			pile			pier		
			concrete	formwork	rebar	concrete	formwork	rebar
		(m.)	$m.^3$	$m.^2$	kg.	$m.^3$	$m.^2$	kg.
85	Yala	150	427.68	3,231.36	105,855	401.24	742.57	61,365
86	Narathiwat	100	151.68	1,155.84	22,416	311.92	663.08	44,627
87	Trang	80	52.20	396.00	7,776	321.58	561.81	40,457
88	Phetchaburi	60	144.00	1,092.00	36,197	179.48	383.54	24,347
89	Narathiwat	240	544.80	4,123.20	137,117	594.72	1,203.32	79,692
90	Prachuap Khiri Khan	90	169.68	1,348.12	41,404	235.46	461.59	30,905
91	Trang	90	203.68	1,541.92	39,836	276.23	500.81	34,072
92	Songkhla	80	346.68	2,521.07	81,826	217.56	417.37	26,647
93	Satun	120	182.89	1,385.52	40,263	385.25	739.59	57,229
94	Patthalung	120	84.56	646.02	12,601	385.84	652.84	49,289
95	Krabi	80	50.12	382.40	7,533	399.32	927.80	51,094
96	Chumphon	120	239.14	1,821.53	45,938	361.23	361.23	61,466
97	Songkhla	160	615.49	4,641.12	151,101	437.40	742.44	66,298
98	Udon Thani	60	35.20	267.20	5,121	284.56	625.76	29,589

Appendix Table B3 (cont'd)

No.	Province	Bridge length	Quantity of materials					
			pile			pier		
			concrete	formwork	rebar	concrete	formwork	rebar
		(m.)	$m.^3$	$m.^2$	kg.	$m.^3$	$m.^2$	kg.
99	Nong Khai	110	149.44	547.68	13,114	316.72	809.04	45,480
100	Loei	130	207.68	1,576.48	30,213	395.91	1,153.33	37,152

Appendix Table B4 Project characteristic of concrete bridge

No.	Province	Bridge length (m.)	Total cost (Baht)	Type of deck				
				no. of span	r.c.slab	plank-girder	box-girder	I-girder
1	Roi Et	140.00	12,207,210	9		4 x 10	5 x 20	
2	Samut Sakhon	120.00	13,879,053	9		6 x 10	3 x 20	
3	Chiang Mai/Lamphun	140.00	16,082,683	7			7 x 20	
4	Chiang Mai	70.00	7,614,300	7		7 x 10		
5	Phayao	80.00	8,547,443	4			4 x 20	
6	Surin	120.00	11,350,321	8		4 x 10	4 x 20	
7	Khon Kaen	100.00	9,775,880	7		4 x 10	3 x 20	
8	Lampang	140.00	12,486,447	7				7 x 20
9	Phetchaburi	100.00	9,103,999	5			5 x 20	
10	Kanchanaburi	160.00	18,021,943	7				5 x 20 + 2 x 30
11	Yala	50.00	4,653,882	3		1 x 10		2 x 20
12	Sing Buri	240.00	23,759,429	13		4 x 10	7 x 20	2 x 30
13	Patthani	80.00	6,941,856	8		8 x 10		
14	Narathiwat	100.00	8,849,281	5				5 x 20

Appendix Table B4 (cont'd)

No.	Province	Bridge length (m.)	Total cost (Baht)	Type of deck				
				no. of span	r.c.slab	plank-7girder	box-girder	I-girder
15	Kanchanaburi	280.00	33,260,867	12				8 x 20 + 4 x 30
16	Ratchaburi	240.00	29,640,509	15				6 x 20 + 4 x 30
17	Phetchabun	100.00	8,511,961	5				5 x 20
18	Ranong	50.00	4,386,079	3		2 x 10		1 x 30
19	Prachuap Khiri Khan	140.00	25,368,961	7		1 x 10	6 x 20	
20	Chaiyaphum	80.00	9,130,019	4			4 x 20	
21	Samut Sakhon	120.00	15,016,951	7		4 x 10	3 x 20	
22	Ratchaburi	50.00	4,592,707	4		3 x 10	1 x 20	
23	Phetchabun	100.00	9,458,000	5			5 x 20	
24	Prachuap Khiri Khan	90.00	8,322,696	5		3 x 10		
25	Surat Thani	150.00	12,146,393	10		5 x 10	5 x 20	
26	Nakhon Si Thammarat	100.00	11,800,348	5			5 x 20	
27	Satun	60.00	6,000,304	3				3 x 20
28	Narathiwat	350.00	45,177,941	15		2 x 10	6 x 20	7 x 30

Appendix Table B4 (cont'd)

No.	Province	Bridge length (m.)	Total cost (Baht)	Type of deck				
				no. of span	r.c.slab	plank-girder	box-girder	I-girder
29	Nakhon Si Thammarat	100.00	12,486,300	5				5 x 20
30	Trang	80.00	7,400,036	4				4 x 20
31	Phitsanulok	120.00	12,783,248	7		4 x 10	3 x 20	
32	Phachin Buri	120.00	13,956,430	6			3 x 20	
33	Chai Nat	60.00	7,532,665	3			3 x 20	
34	Si Sa Ket	150.00	14,983,614	10		5 x 10		5 x 20
35	Chanthaburi	100.00	11,087,736	5			5 x 20	
36	Surin	200.00	18,140,178	10			10 x 20	
37	Sa Kaeo	60.00	5,981,079	3			3 x 20	
38	Uthai Thani	90.00	9,592,804	6	3 x 10		2 x 20	
39	Nakhon Phathom	110.00	6,594,671	7		3 x 10	4 x 20	
40	Lop Buri	160.00	16,289,236	10		4 x 10	6 x 20	
41	Chai Nat	80.00	8,203,901	5		2 x 10	3 x 20	
42	Phichit	140.00	14,586,820	9		2 x 10		3 x 20 + 2 x 30

Appendix Table B4 (cont'd)

No.	Province	Bridge length (m.)	Total cost (Baht)	Type of deck				
				no. of span	r.c.slab	plank-girder	box-girder	I-girder
43	Phichit	170.00	16,985,571	7		3 x 10		4 x 20
44	Phetchabun	130.00	11,463,333	10		7 x 10		3 x 20
45	Sukhothai	170.00	13,925,138	11		5 x 10		6 x 20
46	Phitsanulok	120.00	12,482,321	9		6 x 10		3 x 20
47	Sukhothai	60.00	6,173,825	3			3 x 20	
48	Sukhothai	180.00	24,897,772	7				3 x 20 + 2 x 30
49	Chiang Mai	60.00	6,670,679	4		2 x 10	2 x 20	
50	Lampang	60.00	7,183,748	3			3 x 20	
51	Chiang Mai	160.00	17,295,264	8			8 x 20	
52	Chiang Rai	100.00	11,507,470	7		4 x 10	3 x 20	
53	Lampang	100.00	10,628,821	5			5 x 20	
54	Mae Hong Son	160.00	15,872,784	8			8 x 20	
55	Phitsanulok	120.00	10,772,406	6			6 x 20	
56	Phetchabun	100.00	9,712,701	5			5 x 20	

Appendix Table B4 (cont'd)

No.	Province	Bridge length (m.)	Total cost Baht.	Type of deck				
				no. of span	r.c.slab	plank-girder	box-girder	I-girder
57	Phetchabun	100.00	8,654,004	5			5 x 20	
58	Chiang Mai	140.00	12,358,316	7			7 x 20	
59	Lampang	120.00	10,920,767	6			6 x 20	
60	Uttaradit	80.00	9,912,273	4			4 x 20	
61	Phayao	80.00	8,479,697	4			4 x 20	
62	Lampang	140.00	12,565,004	7				7 x 20
63	Chiang Mai	140.00	15,217,438	7			7 x 20	
64	Phrae	150.00	13,064,460	8		1 x 10	7 x 20	
65	Nan	130.00	13,716,319	6		1 x 10	3 x 20	2 x 30
66	Phrachin Buri	120.00	12,717,320	7		2 x 10	5 x 20	
67	Phra Nakhon Si Ayutthaya	230.00	35,233,269	7			4 x 20	3 x 30
68	Nakhon Nayok	70.00	6,491,708	7		7 x 10		
69	Nakhon Nayok	60.00	4,619,199	6		6 x 10		
70	Samut Prakan	70.00	7,854,905	4		1 x 10	3 x 20	

Appendix Table B4 (cont'd)

No.	Province	Bridge length (m.)	Total cost Baht.	Type of deck				
				no. of span	r.c.slab	plank-girder	box-girder	I-girder
71	Chanthaburi	110.00	10,328,241	7		4 x 10	4 x 20	
72	Chanthaburi	80.00	7,409,583	5		2 x 10	3 x 20	
73	Chachoengsao	70.00	5,160,324	7		7 x 10		
74	Phrachin Buri	120.00	12,717,320	7	1 x 10	1 x 10	5 x 20	
75	Chachoengsao	80.00	8,540,000	7	2 x 10	4 x 10	1 x 20	
76	Phrachin Buri	100.00	12,496,314	7	4 x 10		3 x 20	
77	Buri Ram	130.00	13,065,502	9		5 x 10	4 x 20	
78	Krabi	80.00	11,290,431	4			4 x 20	
79	Songkhla	120.00	13,745,466	6				6 x 20
80	Phangnga	80.00	8,756,844	5		2 x 10	3 x 20	
81	Chumphon	100.00	8,686,866	5			5 x 20	
82	Krabi	60.00	5,732,265	3			3 x 20	
83	Chumphon	100.00	7,829,771	5				5 x 20
84	Patthalung	80.00	6,300,865	4			4 x 20	

Appendix Table B4 (cont'd)

No.	Province	Bridge length (m.)	Total cost Baht.	Type of deck				
				no. of span	r.c.slab	Plank-girder	box-girder	I-girder
85	Yala	150.00	14,887,419	7				6 x 20 + 1 x 30
86	Narathiwat	100.00	8,013,601	5				5 x 20
87	Trang	80.00	6,013,851	4				4 x 20
88	Phetchaburi	60.00	4,996,706	3			3 x 20	
89	Narathiwat	240.00	25,203,478	12			12 x 20	
90	Prachuap Khiri Khan	90.00	6,927,133	4				3 x 20 +1 x 30
91	Trang	90.00	8,602,896	5		1 x 10	4 x 20	
92	Songkhla	80.00	8,791,145	4			4 x 20	
93	Satun	120.00	9,715,103	6				3 x 20 +3 x 30
94	Patthalung	120.00	8,795,163	6				6 x 20
95	Krabi	80.00	7,175,270	4			4 x 20	
96	Chumphon	120.00	11,669,349	6				6 x 20
97	Songkhla	160.00	16,721,430	8			8 x 20	
98	Udon Thani	60.00	5,742,580	3			3 x 20	

Appendix Table B4 (cont'd)

No.	Province	Bridge length (m.)	Total cost Baht.	Type of deck				
				no. of span	r.c.slab	plank-girder	box-girder	I-girder
99	Nong Khai	110.00	8,462,712	5			4 x 20	1 x 30
100	Loei	130.00	12,933,556	10		7 x 10	3 x 20	

APPENDIX C

Appendix Table C1 Variables of Contract Price Escalation Factor (K) Year 2001 (1987 = 100)

Variable		JAN.	FAB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG	SEP.	OCT.	NOV.	DEC.
M	Construction materials (Exclude cement& steel;)	193.8	193.9	193.6	194.0	195.4	195.9	195.0	195.2	196.1	196.2	196.1	195.9
S	Steel price index	119.2	126.3	127.8	128.8	130.8	134.5	136.3	134.2	132.8	131.2	126.5	125.8
C	Cement price index	190.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0	190.0	177.7	140.6
I	Genneral consumer price index of Thailand	181.4	182.4	182.4	183.8	184.4	183.9	183.9	183.6	184.2	183.3	182.9	182.4

Source : Bureau of Trade and Economic Indices

Appendix Table C2 Variables of Contract Price Escalation Factor (K) Year 2002 (1987 = 100)

Variable		JAN.	FAB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG	SEP.	OCT.	NOV.	DEC.
M	Construction materials (Exclude cement& steel;)	196.4	196.7	197.2	197.4	197.7	198.1	200.5	201.6	201.5	201.4	201.3	201.0
S	Steel price index	129.3	132.9	136.1	139.7	139.6	141.1	142.9	144.7	143.1	143.6	141.3	143.0
C	Cement price index	140.1	108.2	140.4	181.1	191.8	177.4	173.0	175.8	174.3	174.3	174.3	176.3
I	Genneral consumer price index of Thailand	182.7	182.9	183.4	184.3	184.5	184.1	184.0	184.3	184.8	185.9	185.0	185.2

Source : Bureau of Trade and Economic Indices

Appendix Table C3 Variables of Contract Price Escalation Factor (K) Year 2003 (1987 = 100)

Variable		JAN.	FAB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG	SEP.	OCT.	NOV.	DEC.
M	Construction materials	202.0	204.9	206.8	206.4	206.9	207.0	207.6	208.9	209.2	209.3	209.9	211.2
	(Exclude cement& steel;)												
S	Steel price index	149.0	159.1	171.9	170.3	165.0	161.3	161.4	163.4	162.5	163.4	165.9	179.5
C	Cement price index	194.4	197.0	196.4	196.4	194.4	194.4	194.4	194.4	194.4	194.4	194.4	194.4
I	Genneral consumer price index	186.8	186.4	186.6	187.3	188.0	187.3	187.3	188.2	188.0	188.2	188.4	188.6
	of Thailand												

Source : Bureau of Trade and Economic Indices

Appendix Table C4 Variables of Contract Price Escalation Factor (K) Year 2004 (1987 = 100)

Variable		JAN.	FAB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG	SEP.	OCT.	NOV.	DEC.
M	Construction materials (Exclude cement& steel;)	212.5	217.9	221.5	222.4	223.7	223.6	224.8	227.3	228.8	230.4	230.4	229.7
S	Steel price index	208.8	224.4	233.6	232.6	217.3	204.1	215.2	235.1	241.8	241.4	234.8	224.7
C	Cement price index	195.3	195.3	195.3	195.3	195.3	193.7	190.6	183.9	177.9	177.7	175.8	173.5
I	Genneral consumer price index of Thailand	189.1	190.5	190.9	191.9	192.6	193.0	193.2	194.1	194.8	194.8	194.1	194.1

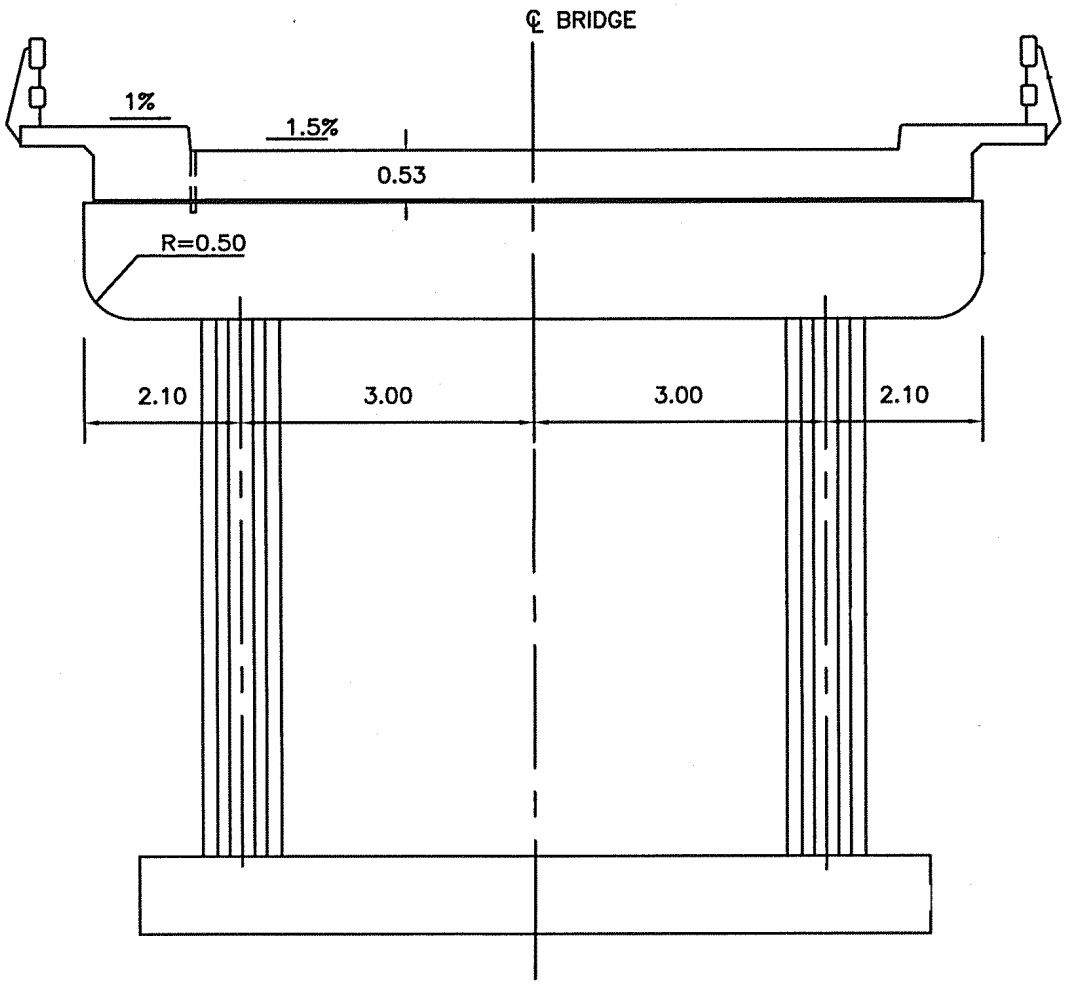
Source : Bureau of Trade and Economic Indices

Appendix Table C5 Variables of Contract Price Escalation Factor (K) Year 2005

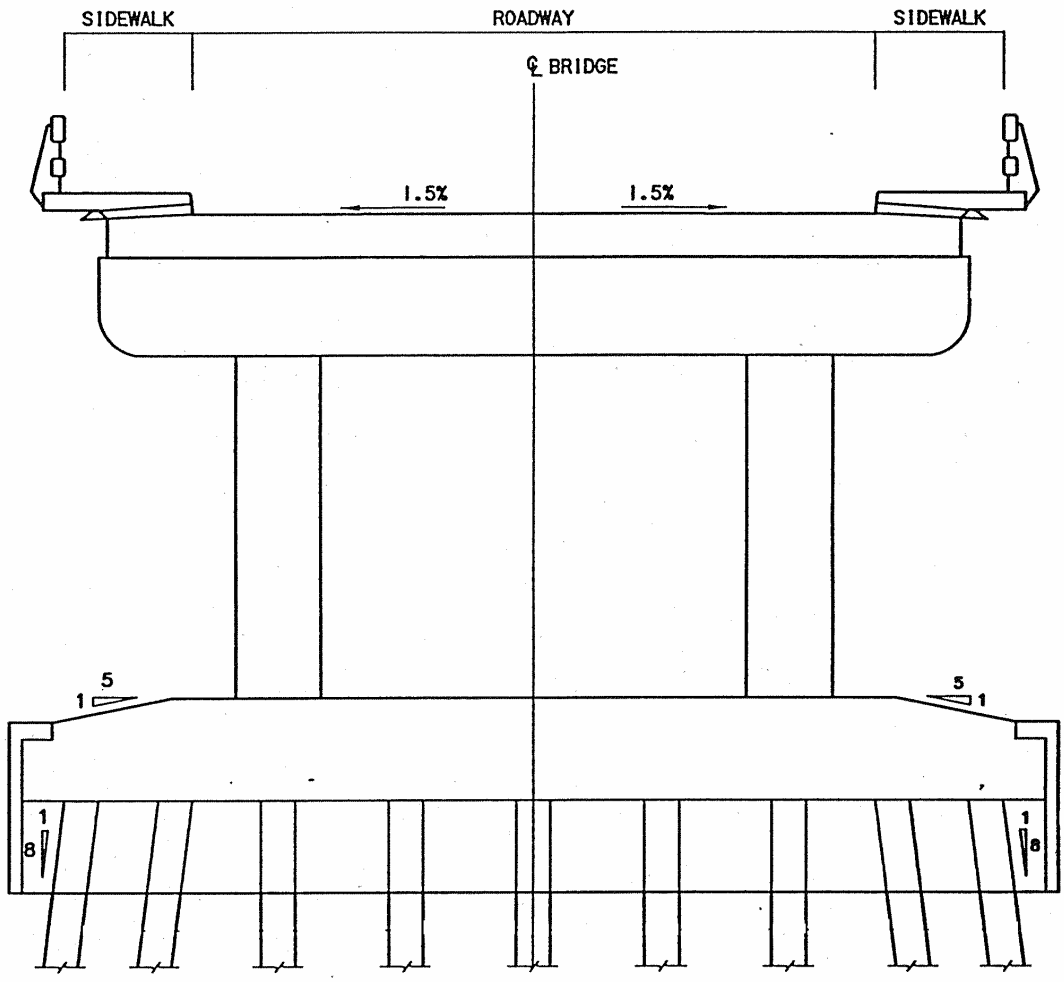
Variable		JAN.	FAB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG	SEP.	OCT.	NOV.	DEC.
M	Construction materials	228.4	229.1	229.7	231.8	232.8	230.9	231.8					
	(Exclude cement& steel;)												
S	Steel price index	226.3	225.4	227.0	227.5	220.1	196.1	200.1					
C	Cement price index	173.7	175.3	176.7	177.4	178.6	178.3	180.6					
I	Genneral consumer price index	194.2	195.3	197.0	187.7	199.8	200.3	203.5					
	of Thailand												

Source : Bureau of Trade and Economic Indices

APPENDIX D



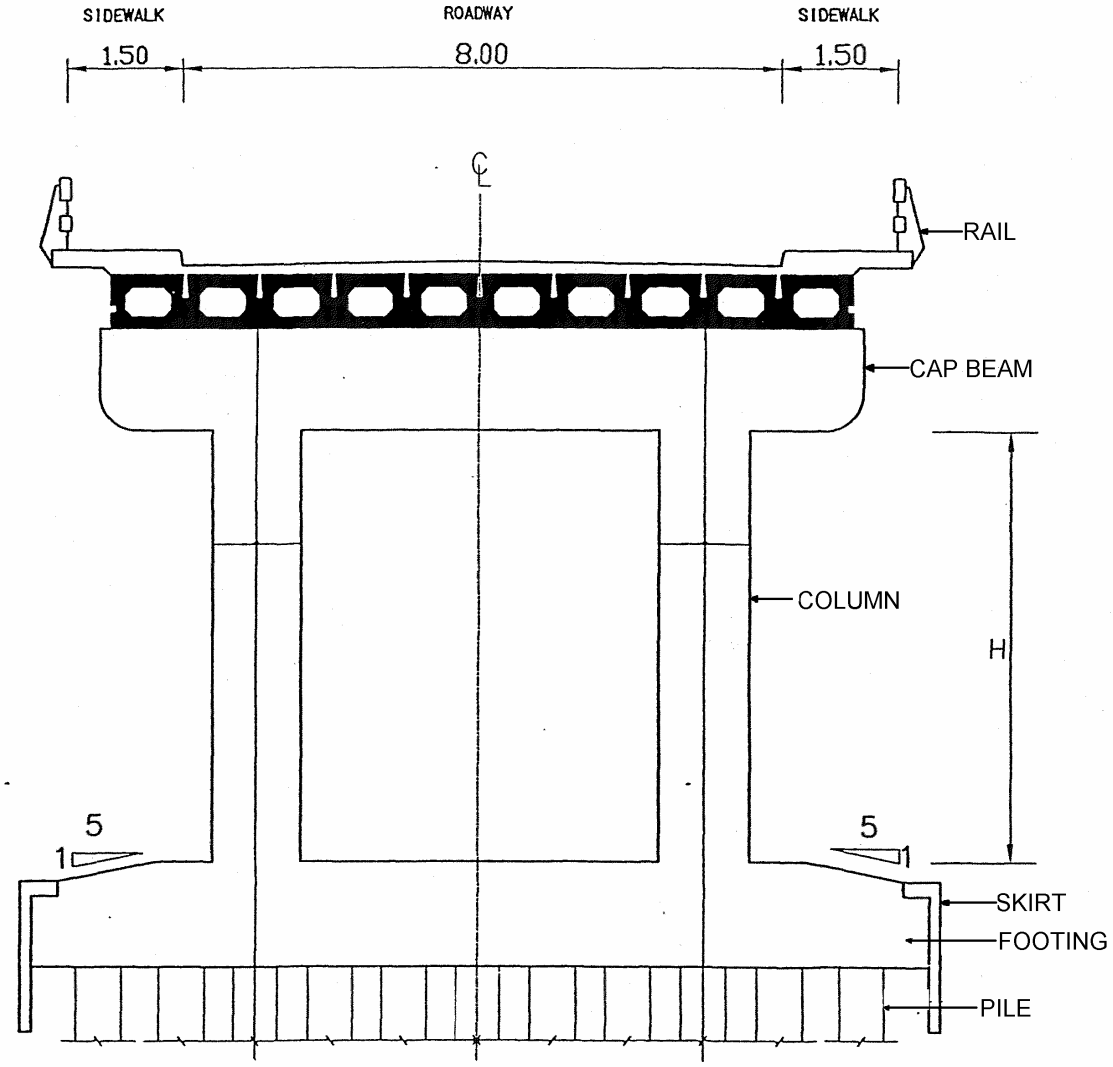
Appendix Figure D1 Standard drawing for pier and r.c.slab deck
(span length 10.00 m.)



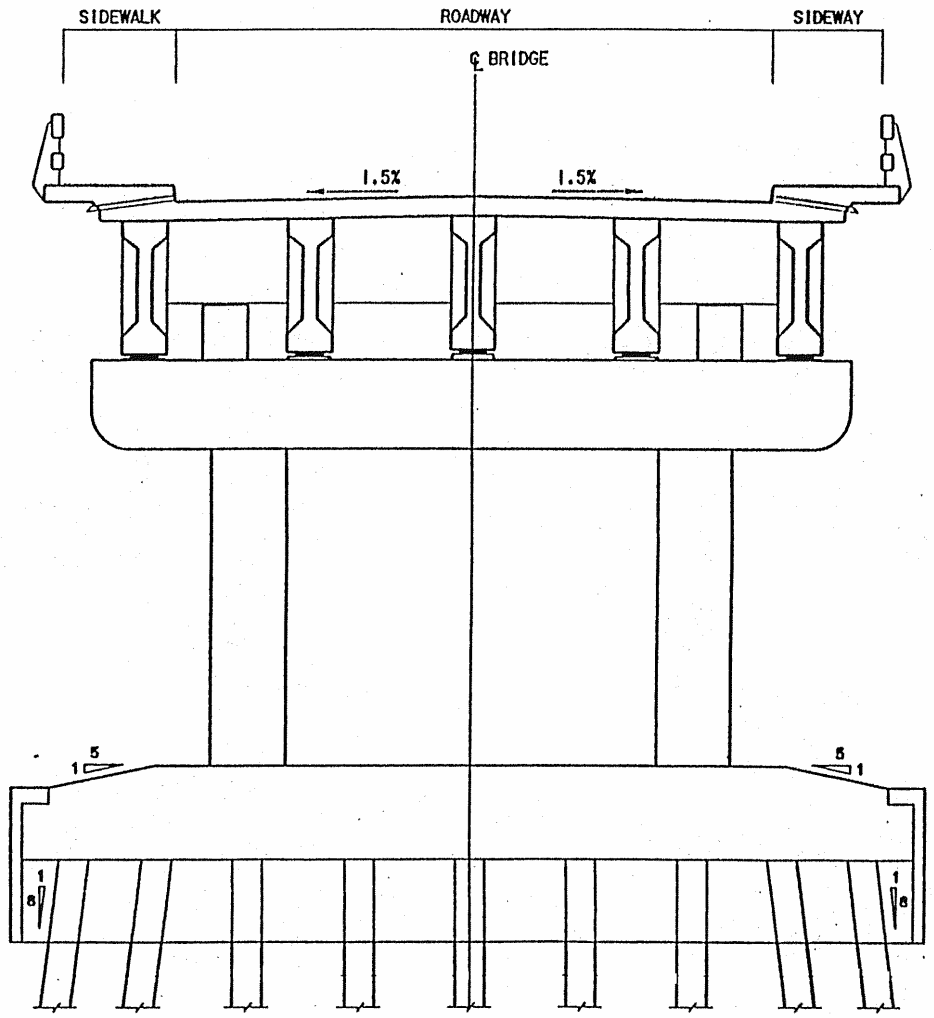
SECTION

SPAN 10.00 m. PLANK GIRDER

Appendix Figure D2 Standard drawing for pier and plank-girder (span length 10.00 m.)



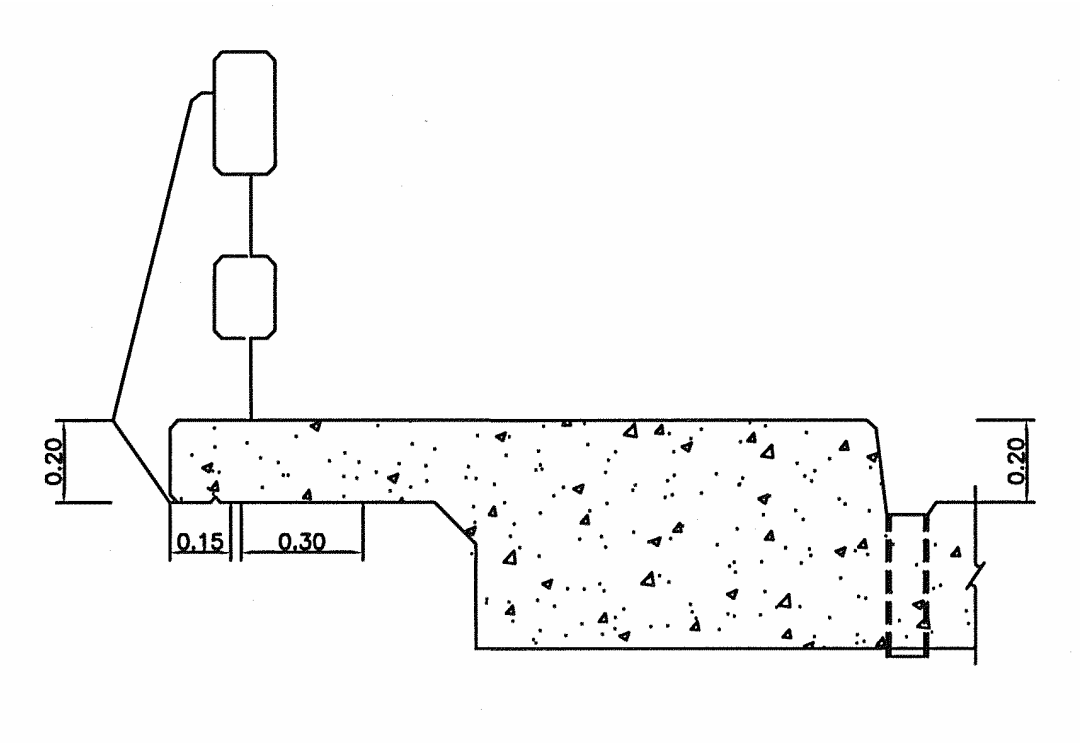
Appendix Figure D3 Standard drawing for pier and box-girder deck (span length 20.00 m.)



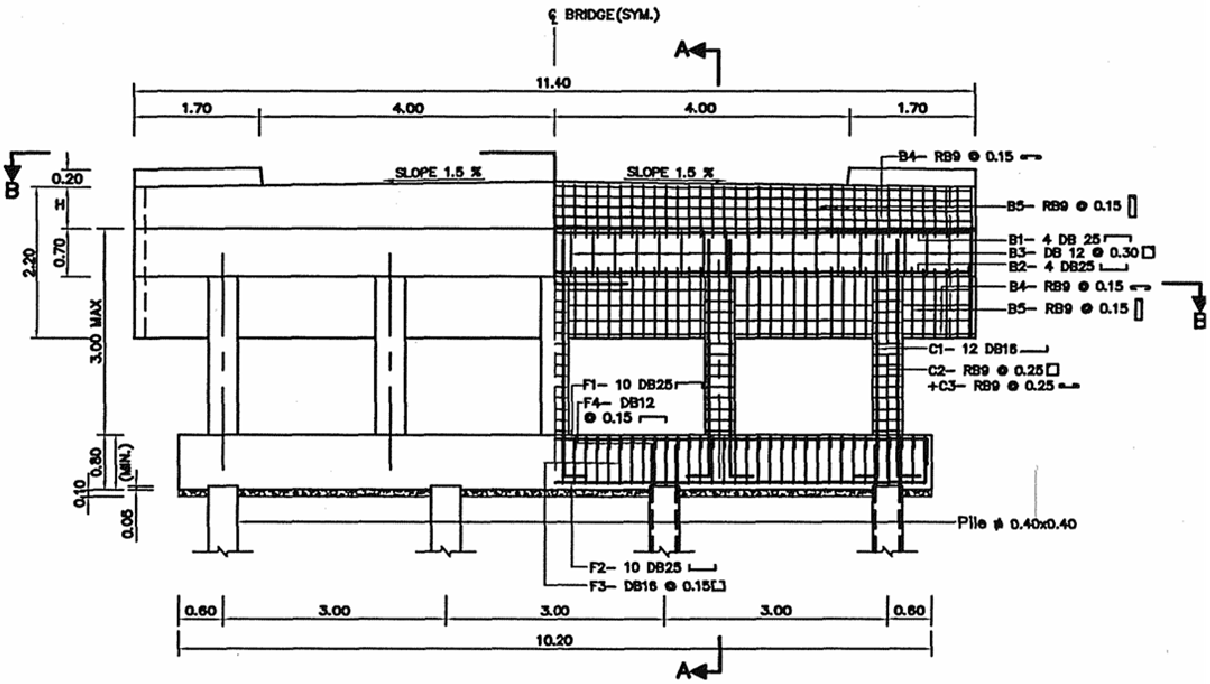
SECTION

SPAN 20.00 m. I-GIRDER

Appendix Figure D4 Standard drawing for pier and I-girder deck (span length 20.00 m.)

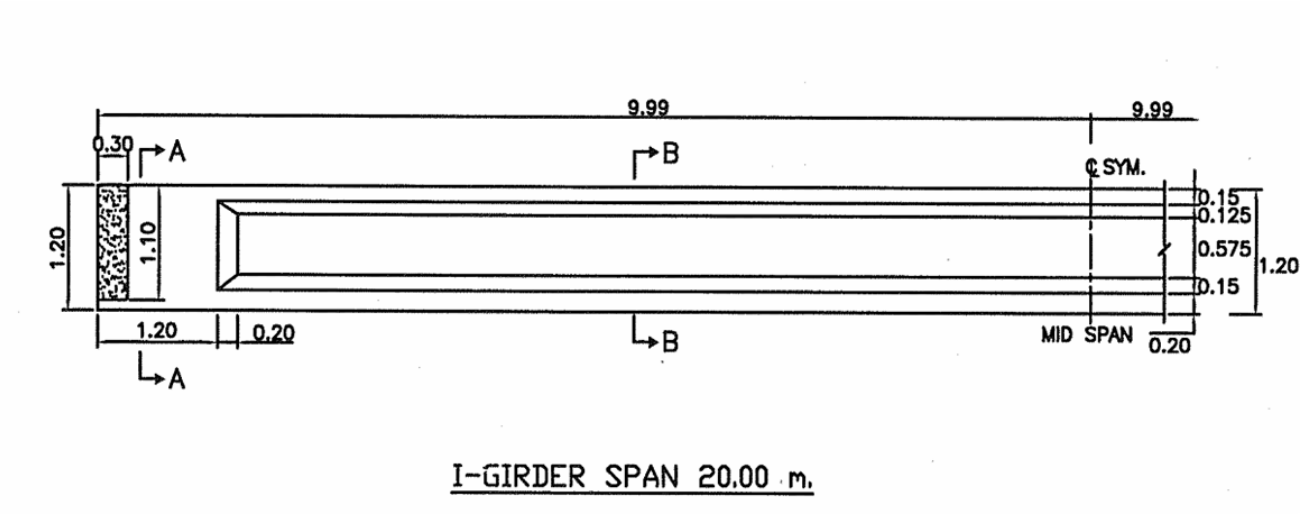


Appendix Figure D5 Standard drawing for sidewalk and rail

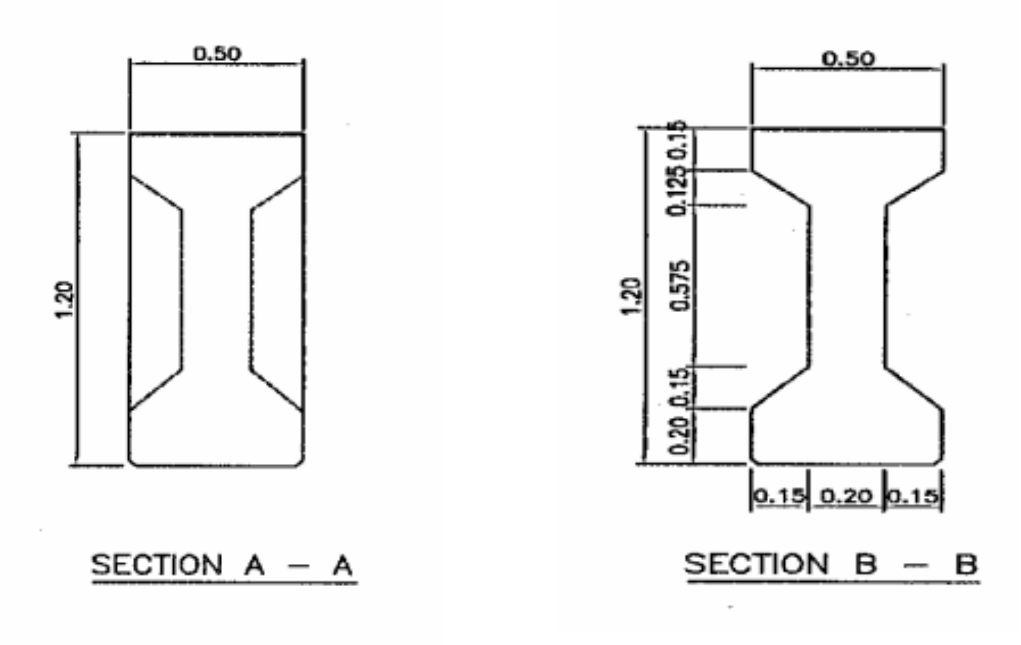


SECTION

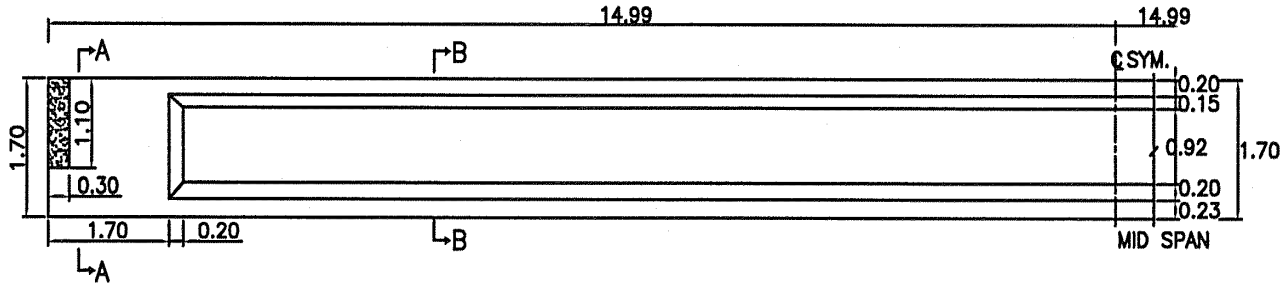
Appendix Figure D6 Standard drawing for abutment



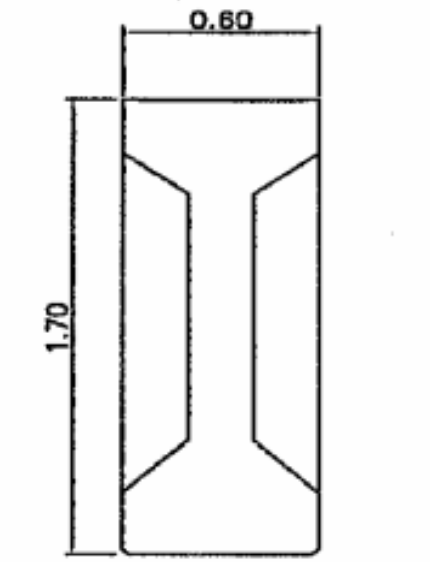
I-GIRDER SPAN 20.00 m.



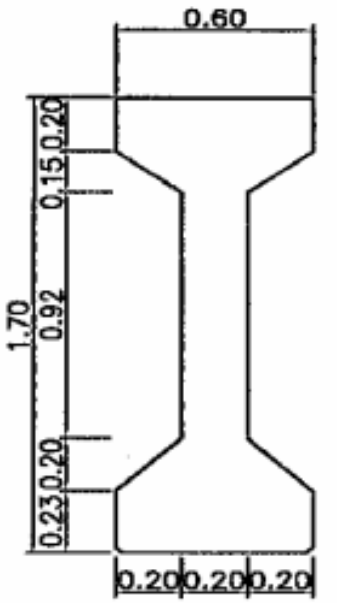
Appendix Figure D7 Standard drawing for section I-girder span 20.00 m.



I-GIRDER SPAN 30.00 m.

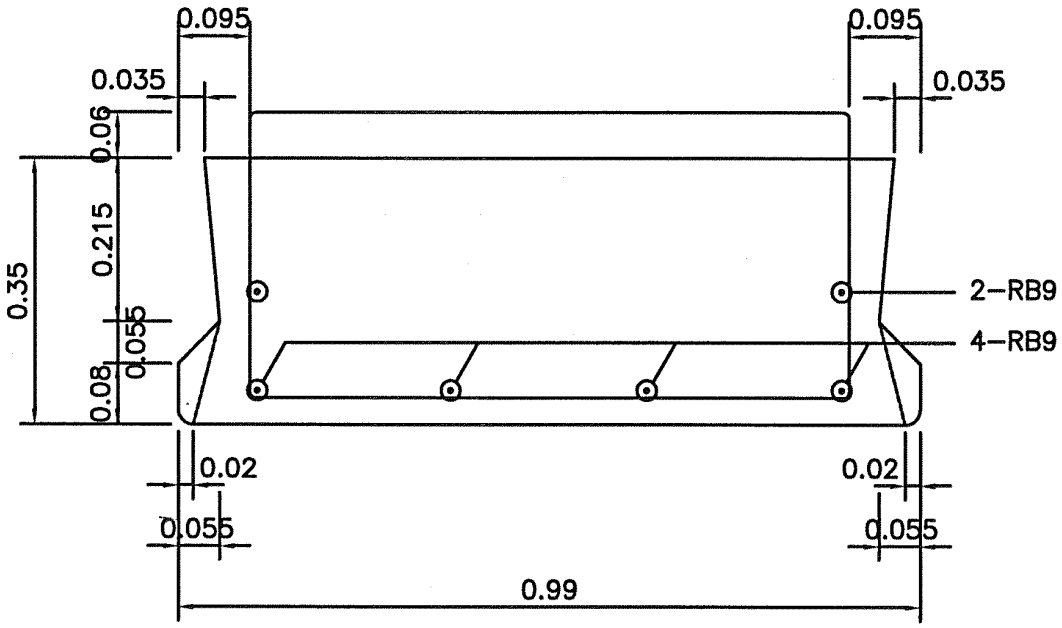


SECTION A – A



SECTION B – B

Appendix Figure D8 Standard drawing for section I-girder span 30.00 m.



Appendix Figure D9 Standard drawing section for plank-girder