Jointly held with

ConCERN 2014

Conference for
Civil Engineering
Research Networks 2014

ACEC

7th ASEAN
Civil Engineering Conference
Under AUN/SEED-Net

Delivering Sustainable Infrastructure
Through Collaborative Research in Civil Engineering

4- 5 November 2014,
ITB Campus, Bandung, INDONESIA

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ConCERN 2014 Introduction

Civil engineering has been considered as one of prominent professions in creating a sustainable world and enhancing the global quality of life. Civil engineers' roles as planners, designers, constructors, and operators of the built environment have been taken for granted by the society, but nowadays, they are also challenged to become the stewards of the natural environment and its resources - sustainable infrastructure is not a jargon, it is a real need for the global society. It is believed that these challenges would only be answered by embracing the roles of civil engineers as innovators and integrators of ideas and technology across the public, private, and academic sectors. Hence, the civil engineering profession can offer the solutions to the society and the environment by taking major part in the infrastructure development process, becoming more aware of social, health, environmental and economic issues.

Innovations in civil engineering and integration among the stakeholders of the infrastructure development could not be possibly done by a party. Global needs and problems faced by the society become comparable, even though some would still be specific for some local conditions, and the specialization as a way of survival in this ever competitive environment called for collaborations in research and development among centers of excellence in the discipline of civil engineering. Despite the fact that collaboration has been an integral part of researching civil engineering for a long time, the nature of collaboration seems to be growing from one of conducting research within a center of excellence to newer areas necessitating partnerships across centers of excellence (e.g. academic, government, private industry).

Having considered the previous established networks of collaboration in civil engineering, the contemporary challenges requires more great deals of collaboration among scholars and practitioners in many centers of excellence. A conference that could cater the dissemination of collaboration results, the establishment of new collaboration, and the augmentation of the established collaborations is one of the immediate agenda to be implemented. Along that line of thought, the Faculty of Civil and Environmental Engineering (FCEE), Institut Teknologi Bandung, Indonesia, initiate an international conference called 'Conference for Civil Engineering Research Networks' or ConCERN in 2014. For the first time, this conference would instigate the thought of collaborations through the research networks in the area of civil engineering that the FCEE have already recognized. Hopefully, the conference would generate more establishments of national, regional and international collaborations for the FCEE, and for the conference participants as well.

7th ACEC Introduction

The ASEAN Civil Engineering Conference (ACEC) under AUN/SEED-Net is a platform to share the most updated technology and research on common regional issues in order to contribute to the ASEAN community and to draw support from the industrial and the governmental sectors. The regional conference allows opportunities for AUN/SEED-Net members to publicise their research work, exchange ideas and discuss future collaborations and activities related to the civil engineering field. The conference itself is not only to enhance the academic network among the ASEAN universities, but also to strengthen the relationship between ASEAN and Japanese professors of each university.

This year, the 7th ASEAN Civil Engineering Conference (ACEC) will be organised with the theme "Delivering Sustainable Infrastructure through Collaborative Research in Civil Engineering" at ITB Campus, Indonesia on 4 – 5 November 2014, held jointly with ConCERN 2014.

Objectives & Sub-themes

The ConCERN 2014, as reflected from its abbreviation, has the following objectives:

- To provide a platform for educators, scholars, practitioners, governments, and companies in construction industry to meet and exchange ideas;
- To provide an environment to disseminate research findings and innovations in the area of civil engineering as a result of collaboration and networks; and
- To fortify and expand collaborations in the civil engineering research networks.

The selected papers to be discussed in this conference would cover research ideas, findings, and innovations in the following sub-themes:

- **Structural Engineering and Materials**
- **Geotechnical Engineering**
- **Transportation Engineering and Planning**
- **Water Resources Engineering and Management**
- **Construction Engineering and Management**
- **Infrastructure Engineering and Management**

Programs

Day 1: Tuesday, 4 November 2014
Time: Morning
- **Opening Ceremony** (Plenary) **& Guest Speakers** (Plenary)

Time: Afternoon
- **Technical Paper Presentations** (Parallel)

Time: Evening
- **Cultural Dinner** (Plenary)

Day 2: Wednesday, 5 November 2014
Time: Morning
- **AUN/SEED-Net Field Management Meeting, Technical Paper Presentations** (Parallel), **& Closing Ceremony** (Plenary)

Time: Afternoon
- **Research Collaboration and Networks Meetings** (Parallel)
- **Side Events**

Keynote Speakers

- **Prof. George Ofori:** Ethics and Personal Responsibility in the Construction Industry, National University of Singapore, Singapore.
- **Prof. Susumu Iai:** Combined Geotechnical Hazards Due to Tsunami and Earthquakes, Kyoto University, Japan.
- **Prof. Akimasa Fujiwara:** Analyzing Air Quality Based on Limited Monitoring Data in Developing City, Hiroshima University, Japan.
- **Prof. Kazuhiko Kasai:** Paper title to be announced, Tokyo Institute of Technology, Japan.
- **Prof. Kusuma.,** et al.: Paper title to be announced, Water Resources Research Group, Institut Teknologi Bandung, Indonesia.

Invited Speakers

- **Djayanta Ginting:** Concrete That Contribute to Sustainable Construction, Value Added Solution Manager of Holcim Indonesia
- **Muh. Najib Fauzan:** Paper title to be announced, Director of Human Resources and General Affairs, Indonesian Highways Corp.
- **Nobuo Masaki, Dr.Eng.:** Computing Algorithm of Hysteresis Model of Deformation-History for Isolator, Bridgestone Corporation, Japan.

Place & Date

4- 5 November 2014

ITB Campus
Bandung, INDONESIA

Participants

The participants of the conference are expected to be civil engineering's scholars, government officers, designers, contractors, consultants, lecturers, students, and suppliers. The total attendant is expected to be around 200 people, coming from countries in the Asia Pacific region.

Papers Presented

We have reviewed and accepted 132 abstracts from Hong Kong, Philippines, Thailand, Vietnam, Japan, Bangladesh, Malaysia, Singapore, Taiwan, Korea, Norway, New Zealand, Myanmar, and Indonesia.

Important Dates (in 2014)

- Deadline of **full paper** submission: **15 Sep**
- Full paper acceptance notification: **29 Sep**
- Deadline of registration: **18 Oct**
- Deadline of revised full paper submission: **20 Oct**
- Conference for Civil Engineering Research Network (ConCERN 2014): **4-5 Nov**

ConCERN 2014 Secretariat

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Registration

Please fill in the registration form at:
http://concern.itb.ac.id/registration.html

The registration will be closed on **18 October 2014.**

Category
- International participant: **USD 200**
- International student participant: **USD 150**
- Local participant: **IDR 1.500.000**
- Local student participant: **IDR 1.000.000**

Limited numbers of financial supports are available based on proposal to the Organizing Committee.

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Getting to Bandung

For international participants, to get to the city of Bandung, you may use the Soekarno-Hatta International Airport (SHIA), at Cengkareng, near Jakarta (capital city of Indonesia, about 150 km from Bandung), or the Husein Sastranegara International Airport (Husein) at Bandung. The SHIA is serving major airlines from all around the world. From Jakarta, you can take a train, shuttle buses or travel mini buses to get to Bandung. However, the Husein airport is serving limited number of airlines, and only from Singapore and Kualalumpur, Malaysia.

If you need more information on how to get to Bandung from the SHIA, Jakarta, please visit this site:
http://www.international.itb.ac.id/web/?page_id=67

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Road User Cost Assessment Approach in Calculation of Life Cycle Cost for Projects Contracted Using Performance Based Contract

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***Abstract*—PBC is one type of innovative contract which is currently the best technique for road maintenance contract. Implementation of PBC requires performance indicators which are road-user based and also can be expressed in economic terms (such as minimization of vehicle operating cost, travel time cost, and accident cost). This study aims to develop an appropriate RUC approach and assessment framework to assess LCC for PBC national road projects. To develop a specific approach to assess RUC on PBC projects, the initial stage is to conduct a comprehensive literature review on the concept of RUC assessment in the LCCA. Survey using semi-structured interviews conducted to identify the characteristics of PBC projects which have an impact on road users as well as to identify the variables that affect the RUC assessment process for PBC projects. Based on the results of a literature review and interviews with the parties involved in PBC project, the approach and framework for RUC assessment are further developed. The results of this study showed that the assessment of cost efficiency for road users on national road contracted using PBC should be done for VOC, TTC, and ACC in work zone conditions and also in-service condition.**

Keywords— Road-User Cost; National Road; Maintenance; Performance-Based Contract

I. INTRODUCTION

Performance Based Contract (PBC) is one type of innovative contracts for road maintenance work. Reference [1], [2], [3], and [4] states that currently PBC is the best technique for road maintenance contract. PBC sets minimum quality and performance of road that must be met by contractor during the long period of contract. PBC requires clear and measurable performance indicators. Reference [5] states that road users' comfort and safety is an important factor in developing performance indicators. Reference [6] states that the performance indicators shall meet several goals, among others: (a) minimize the total cost of system, including long-term costs for road maintenance; (b) minimize the cost for road users; and (c) provide comfort and safety for road users. In general, performance indicators should be based on road users and can also be expressed in economic terms (such as reduction of vehicle operating cost, travel time cost, and accident cost).

Currently, national road agency are being shifted the traditional contract to PBC. As a relatively new approach in the management of national road, it needs a long-term benefit assessment on PBC implementation to road users. Cost savings is the most appropriate representation of innovative contract, so the concept of cost-efficiency is most widely used to assess the benefits from innovative contract implementation [7]. Potential cost savings information for road user could determine the appropriateness of decision to contracting out the maintenance work of national road under PBC scheme. Cost savings estimation for PBC using life cycle cost (LCC) model is the most appropriate approach [6].

Assessment of long-term cost efficiency for road users on the road contracted using PBC scheme should be based on valid and consistent analysis. Life Cycle Cost Analysis (LCCA) is an appropriate approach to be used to assess the efficiency of long-term investment in road projects [8], [9], [10], [15], and [16]. In general, LCCA involves consideration of Road User Cost (RUC) during the analysis period [8], [11], [12], and [13]. This study develops RUC assessment approach and framework to calculate LCC specifically for national road maintenance projects contracted using PBC scheme.

II. METHODOLOGY

To develop a specific approach to assess RUC on PBC project, the initial stage is to conduct a comprehensive literature review on the concept of RUC assessment in the LCCA. Survey using semi-structured interviews conducted to identify the characteristics of PBC projects which have an impact on road users as well as to identify the variables that affect the RUC assessment process for PBC projects. Based on the results of a literature review and interviews with the parties involved in PBC project, the approach and framework for RUC assessment are further developed. RUC approach and framework in this study demonstrate a variety of RUC input variables and assessment process, so as to provide an overview of PBC effectiveness in Indonesia. In this study, the

development of RUC approach and framework that will be developed is restricted to an alternative of national road works projects with high traffic which is contracted using PBC scheme.

III. LCCA Method

LCCA is an analytical technique that uses economics principles to evaluate long-term investment option. LCCA can be used to determine an alternative that meets the project objectives with the lowest cost and determine the most viable alternatives by comparing the LCC difference on aspects of pavement type selection, determine optimum service life, and selection of road works strategy. To perform LCCA, it requires an alternative design, analysis period, discount rate, a series of road works activities, as well as costs.

LCCA in road projects generally take into account the cost to road agency and road users that will occur throughout the life of the project. Road user costs are a significant component affecting the value of LCC especially on roads with high traffic volume. Reference [14], [15], and [16] showed that the cost of road users should be considered when determining the road design suitability for a long-term, because these costs usually exceed the road agency cost significantly.

Road user costs represent costs incurred due to road works activities or work zone as well as costs incurred in normal traffic conditions or in-service. RUC on road work project generally consists of three cost components, namely the Vehicle Operating Cost (VOC), Travel Time Cost (TTC), and Accident Cost (ACC). Reference [17] states that many methods have been developed to assess the RUC on road work projects, but none is a perfect method, as each project to be assessed has unique characteristics and requires specific assumptions and adjustments.

IV. Various Methods of RUC Assessment

The United States and some states actively develop and update the RUC valuation methodology for assessing the cost effectiveness and benefits of road work projects. FHWA developed a method comprising the RUC assessment of VOC components, TTC, and ACC. Description of the RUC assessment methodology developed by FHWA [18] can be seen in Table I.

TABLE I. RUC Assessment Methodology in the United States

RUC Component	Methodology
Component Considered	VOC, TTC, ACC
RUC Definition	Estimated costs associated with travel delays during the road works period along the analysis period of LCC.
RUC Category	Work zone condition (causing addition of RUC)
RUC Assessment	Based on the input of work zone activity: • Obtained from traffic management plan of projects reviewed • Available database of construction productivity rate • Available database of vehicle capacity value for a certain number of lanes

Australia through the Australian Road Agency also regularly update the unit value for RUC. RUC component in this approach consists of VOC, TTC, ACC, and externality costs (costs associated with environmental and social impact). Description of RUC assessment methodology developed by the Australian Road Agency [19] can be seen in Table 2.

TABLE II. RUC Assessment Methodology in Australia

RUC Component	Methodology
Component Considered	VOC, TTC, ACC, and externality cost (costs associated with environmental and social impact).
VOC	• Consists of fuel consumption, lubricating oil, tire use, repairs and maintenance, and vehicle depreciation. • Influenced by vehicle type, vehicle speed, road roughness, road alignment, traffic conditions, road maintenance, environmental impact, and driving habits.
TTC	• Determined based on travel purpose (private vehicle and public transportation) • Based on the assumption that the value of travel purpose is suitable to replace the loss (in monetary cost) from the trip itself and the opportunity cost from travel time. • Use Willingness to Pay (WTP) approach and Wage Rate approach.
ACC	• Expressed as the economic value of damages caused by vehicle crashes. • Consists of internal costs (associated with the damages and risks to road users for a specific vehicle type) and external costs (as uncompensated damages and costs that have an impact to other parties). • Use WTP approach (for ex ante) and human capital approach (for ex post). ➢ For WTP approach, ACC expressed as WTP of individuals in avoiding accidents that have an impact on fatality, injury, and damage. ➢ For Human Capital approach, ACC reflected as potential revenue, because the value of a lost life is assumed as a reduction in earnings for the accident victim itself.

Development of RUC assessment methods in developing countries also have been carried out. One of them was developed by the State of Bangladesh through the Roads and Highways Department (RHD) - Ministry of Communications, which has developed a methodology for assessing the RUC since 1995 and update the study every year. Reference [20] states that the RUC components consist of VOCs, TTC, and ACC. Description of the RUC assessment methodology developed by RHD [20] can be seen in Table 3.

TABLE III. RUC Assessment Methodology in Bangladesh

RUC Component	Methodology
Component Considered	VOC, TTC, dan ACC.
VOC Assessment	• VOCs are the physical costs of vehicle operation. • Assessment step: (1) selection of representative vehicle type, (2) identification of characteristics use of vehicles and its service life (to determine the average km vehicle use and vehicle depreciation), (3)

	calculation of consumable cost (consisting of tire cost, fuel and lubricants costs, vehicle maintenance costs, crew costs, and overhead costs).
TTC Assessment	• TTC is the value of time spent in a trip that can be used for other activities (based on the concept that the time spent in the trip has the opportunity cost that can produce benefits). • It accounts in-vehicle time values only. • Expressed as hourly values per vehicle by assuming vehicle average occupancy and loading factors for each type of vehicle. • Use the average wage approach (TTC value for the work time is estimated as the wage rate, while the TTC value for non-work time is set at 35% of the wage rate).
ACC Assessment	• ACC is the physical cost of accidents and injuries where the value is measured in fatalities. • Use the Lost Output (Human Capital) approach.

In Indonesia, the RUC assessment has been developed by National Road Agency - Ministry of Public Works. RUC assessment carried out to calculate VOC in the free flow and congested conditions. The RUC assessment becomes part of the evaluation of economic viability of road works project. VOC in this approach is a function of the type and speed of vehicles on roads with certain characteristics (type of pavement, pavement width, road roughness, etc.). The RUC assessment approach has yet to include a component in the ACC and TTC for economic feasibility assessment of road works project. Despite the economic viability of road works project in Indonesia only requires assessment of VOC, but much research has been done to develop methodologies of ACC and TTC assessment in Indonesia.

Generally RUC assessment can be done using a simulation model or calculations using manual techniques (using tables, graphs, and hand calculations). RUC calculation is generally done using either before-versus-after approach for road projects improvement capacity, as well as use during-construction-versus-after approach for road rehabilitation projects [21].

V. National Road Works Using PBC Scheme

The results of a survey conducted through semi-structured interviews to respondents involved in PBC project as a case study indicate that the PBC requires a minimum performance standard that indicates the quality of road conditions that must be met by contractor. The minimum performance standard is expressed as roads level of service and specifically defined in the performance specifications and output in the contract documents. PBC for national road works in Indonesia are not only aims to improve the quality of roads, but also to improve the effectiveness of management and maintenance of national roads. Implementation of PBC is expected to guarantee the physical condition of road in accordance with the performance provisions or minimum service levels during the contract period.

In PBC approach, road works are carried out in accordance with predetermined performance indicators as well as considering the road conditions. Implementation of PBC requires the contractor to continuously supervise and control the road conditions and level of service for the entire road section that is contracted using PBC scheme. The works and services to be performed by contractor include the road pavement structure and traffic management. Traffic management should be carried out during the construction period up to maintenance and warranty period. Traffic management should include traffic control system that meets the operational requirements of the road, allowing traffic to flow efficiently and safely at the time of entering, passing through, until exit from the work zone.

PBC also require the contractor to ensure that the road is open to traffic and free of distractions. Service level criteria for this case study project related to the comfort and safety for road users and also related to road durability. Contractors on the project reviewed in this study shall meet the service levels at the stages as shown in Table 4.

TABLE IV. Schedule Fulfillment of Service Level

No of month since the contract begin	Roads can be used (% of total lane length)	Road User Comfort (% of total lane length)	Road Durability (% of total lane length)
1-7	100	No minimum limit	No minimum limit
8	100	30	30
9	100	40	40
10	100	50	50
11	100	60	60
12	100	70	70
13	100	80	80
14	100	90	90
15	100	100	100
16 until completion	100	100	100

Source: Contract Document of PBC Project in Ciasem-Pamanukan

VI. Development Assessment Approach and Framework of RUC in LCC Calculation For PBC Projects

Based on the results of semi-structured interviews to road agencies and contractors on PBC projects were reviewed and based on the results of the study on contract documents, it can be stated that PBC project potential to generate RUC efficiency, because this contract approach emphasizes the fulfillment of road services. In PBC, the contractor is obliged to control the impact of construction work to the road users through traffic management, so the project could potentially generate RUC efficiency in work zone conditions. PBC also requires the contractor to fulfill the performance indicators along the period of service and warranty. Under this provision, then the assessment of RUC should also be conducted in-service conditions to ensure that the quality of the road are met in accordance with predetermined performance indicators. Based on the above, it can be stated that RUC at PBC project is cost estimation of the road users arising from the road works activities and normal traffic conditions. RUC in the presence of road works activities is a function of work zone causing reduced capacity and slowing road travel speed; while RUC in normal traffic conditions is a function of road roughness.

A guarantee for road service and quality of PBC project can increase the vehicle's travel speed. Along with the increase in

travel speed, the TTC will be decreased, but this condition potentially increases VOC and ACC. Thus, RUC assessment on national roads with high traffic volume characteristics which is contracted using PBC scheme should consider VOC components, TTC, and ACC. Relevant and appropriate approaches to assess the RUC on national road projects in Indonesia which is contracted using PBC can be formulated as follows:

- VOC on PBC projects declared as physical operational costs of vehicle through roads that were contracted using PBC scheme. Physical costs that must be taken into account include all consumable costs associated with vehicle operations. Because VOCs are influenced by variable type and condition of vehicle and the road, then the VOC calculation should be based on VOC unit cost, where the estimation of unit cost was carried out by analyzing a representative 1 km section of road at different levels of roughness.
- TTC is the value of time spent in a trip that can be used for other activities. Theoretically, the TTC may consist of in-vehicle time and out-of-vehicle time (for example waiting time of vehicles). Because the contracted national roads using PBC is generally a rural and inter-urban road, the TTC on this model can take into account in-vehicle time values only. Since there are large differences among users of motorized and non-motorized vehicles that cause differences in the type of vehicle assessment, the TTC assessment in accordance with the condition of PBC project is to use a uniform value that is represented by a motorized vehicle alone. TTC calculations can use the WTP approach or using the average wage approach.
- ACC is the economic costs caused by traffic accidents on roads that are contracted using PBC scheme. ACC assessment approach generally consists of lost output (human capital) approach and WTP approach. Because Lost Output approach focuses on the economic consequences of the accident; while the WTP approach can be used to determine the value of accident prevention, the assessment on ACC for PBC projects basically can be done using one of two approaches.

Various approaches of RUC assessment above are relevant and appropriate to assess the national road work projects in Indonesia contracted under PBC scheme. RUC calculations for PBC projects should be done through direct field surveys and need to be supported by the availability of valid secondary data, so that the assessment results are valid and describe the actual conditions. RUC value must be evaluated through a case study in the field based on the typical cross section, type of pavement, pavement width, traffic operations data, and various assumptions used should be evaluated with the actual situation. Valid RUC assessment result in PBC projects can be used as a basis for determining the incentives and disincentives for contractor, because the value of RUC could represent the road performance and also contractor's effectiveness in implementation of road works.

RUC assessment in LCCA should be done along the LCC analysis period. The value of RUC during the analysis period is affected by condition or characteristics of roads which is contracted using PBC (that is type of pavement, pavement width, length of roads, as well as road service life). RUC value is also strongly influenced by road works strategies (including the scope and schedule of road works). In PBC projects, road works strategy is strongly influenced by road performance. RUC framework on LCCA for national road projects which is contracted using PBC can be described as follows:

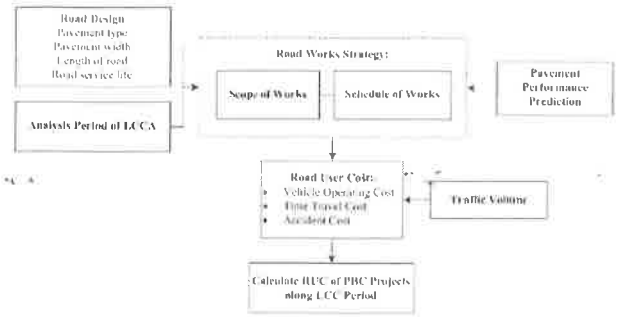

Fig. 1. RUC Framework Assessment in LCCA of National Road Contracted Using PBC.

VII. Conclusions and Recommendations

PBC for national road projects in Indonesia are mostly applied on rural roads with characteristics of high traffic volume. In line with the concept of PBC which aims to maintain the quality and level of service of roads, both during construction period and after construction activities completed, the application of PBC should be sought to minimize the cost to road user. Road user cost efficiency on national roads contracted using PBC scheme should consider VOC components, TTC, and ACC in the work zone conditions and also in service condition. VOC assessment on PBC projects should take into account all the consumable costs associated with vehicle operations. TTC assessment in PBC project may take into account in-vehicle time values only, because PBC projects generally a rural and inter-urban road. TTC calculations can use WTP approach or using the average wage approach. ACC on PBC projects are expressed as economic costs caused by traffic accidents on roads that are contracted using PBC scheme. Assessment of ACC on PBC project basically can be done using Lost Output and WTP approach. In order to obtain a valid value of RUC and describe the actual conditions, then the RUC assessment must be carried out through direct field surveys and need to be supported by the availability of valid secondary data. Valid RUC assessment result in PBC projects can be used as a basis for determining the incentives and disincentives for contractor, because the value of RUC could represent the road performance and also contractors effectiveness in implementation of road works.

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