

ABSTRACT

Cracks of precast box culvert have arisen due to improper quality of materials, incorrect specifications, faulty design, and mistakes in construction process or extreme environmental conditions. At the same time, external factors such as soil-water pressure, and soil movement, can contribute to the damage of these structures. The defects developed in any one particular component in a box culvert can extend and make weaken the box culvert to resist the loads. This study presents an investigation into the crack problems of 11 units precast box culvert elements. The investigation consists of tests which have been conducted to determine the causes of cracks and failure due to construction or design on the East Coast Highway Project Phase II – Bukit Besi to Bukit Payung. The methodology of this study have been carried out through a study of project documents, a site visit, and an analysis of the results of testing conducted upon the material used in the project. In this studies the nondestructive and destructive test were carried out to find the root causes of the problem in the culvert structures. As the results of investigation shows that the cracks of precast box culvert is due to constructions deficiencies such as overloading of backfilling, workmanship during manufacturing and not enough reinforcement as a design.

ABSTRAK

Kewujudan keretakan pada “precast box culvert” adalah disebabkan oleh kualiti bahan yang rendah, spesifikasi yang tidak tepat, kesilapan rekabentuk, kesilapan semasa proses pembinaan dan keadaan alam sekitar yang tidak menentu. Selain itu, faktor luaran yang menyumbang kepada kerosakan struktur tersebut adalah tekanan air dalam tanah dan pergerakan tanah itu sendiri. Ini akan menyebabkan komponen “box culvert” menjadi lemah dan tidak berupaya menanggung beban yang bertindak terhadapnya. Kajian ini menerangkan tentang penyiasatan masalah keretakan bagi 11 unit “precast box culvert”. Penyiasatan ini dijalankan di Lebuhraya Pantai Timur Fasa Ke-2 – dari Bukit Besi ke Bukit Payung bagi mengenalpasti masalah kegagalan dan keretakan samada disebabkan oleh kesilapan semasa pembinaan atau dari segi aspek rekabentuk. Kaedah metodologi kajian yang digunakan adalah berdasarkan kepada dokumen projek sedia ada, lawatan ke tapak dan analisis keputusan ujian-ujian yang dijalankan terhadap konkrit digunakan dalam projek tersebut. Ujian-ujian yang terlibat dalam mengenalpasti punca masalah kegagalan adalah ujian tanpa musnah dan ujian pemusnah. Hasil keputusan daripada ujian yang dijalankan menunjukkan keretakan pada “precast box culvert” adalah disebabkan oleh faktor pembinaan yang mana melibatkan beban lebihan terhadap tambunan tanah, hasil kerja semasa proses pengeluaran dan kekurangan besi tertulang pada anggota struktur.

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Precast concrete box culverts have many uses in civil engineering and construction applications. They are used to channel fluids such as storm water and sewerage, for water retention, storm drainage, utility conduit, holding tanks, underpasses, service tunnels, outfalls, bridges and access ways.

When considering a precast concrete box culvert versus a structure of another material such as steel, the precast concrete box culvert offers many advantages. Precast concrete is strong and durable. Producing the box culvert in a factory eliminates some of the environmental factors on job sites (temperature, poor material quality, uncertified craftsmanship, improper curing, and inclement weather) that can adversely impact quality of other materials [IBS Digest ,2005]. High-quality sealants are used to ensure water-tightness of a precast concrete box culvert. Precast products are readily available for immediate use. Precast concrete is an environmentally friendly material and has a long life span. Finally, being more cost effective than competing materials, precast

concrete helps keep a project within budget. Installation time is greatly reduced since the precast concrete box culverts are ready to install as soon as they arrive at the site.

1.2 PROJECT BACKGROUND

The East Coast Expressway or ECE is a 350 km (217 mile) long, closed toll, 4-lane expressway (2 per direction) beginning from the end of the Kuala Lumpur-Karak Expressway at the Karak Toll Plaza in Karak, Pahang through Lanchang, Mentakab, Temerloh, Cenoh, Maran, Sri Jaya, Gambang, Kuantan, Jabor, Chenih, Chukai, Kijal, Kerteh, Paka, Dungun, Bukit Besi, Ajil, Telemong and ending in Chendering near Kuala Terengganu in Terengganu. It provides a link from the West Coast of Peninsular Malaysia to the East Coast of Peninsular Malaysia. The expressway links many major cities and towns in east coast Peninsular Malaysia, acting as the 'backbone' of the central of the peninsula. **Figure 1.1** shows highways in Malaysia

East Coast Expressway passes through 3 states on the peninsula: Selangor, Pahang and Terengganu. It provides a faster alternative to the old Federal Route, thus reducing travelling time between the cities. The planning of the East Coast Expressway started in the mid-1990s when the Kuala Lumpur-Karak Expressway was upgraded from the former two lane highway into a dual-carriageway expressway in 1997. Construction of the East Coast Expressway began in 2000, with Phase 1 (Karak-Jabor) opened in 22 April 2004. Phase 2 of the expressway, which will extend the highway to Terengganu, is currently under construction and is scheduled for completion in May 2011. The length of this phase is 190 km (118 miles) and will begin from Jabor, Chenih, Chukai, Kijal, Kerteh, Paka, Dungun, Bukit Besi, Ajil, Telemong until Chendering near Kuala Terengganu. The second part of Phase 1, the Sri Jaya and Jabor was opened in 15 July 2007. Malaysian Public Works Department (JKR) manages the design and construction for two stretches of the East Coast Expressway.

This case study has been made to determine the cause of crack in precast box culvert. The site of study is located at the East Coast Highway Project Phase II – Bukit Besi to Bukit Payung, Kuala Temong, Terengganu. **Figure 1.2** shows the East Coast Expressway from Bukit Besi to Bukit Payung, Kuala Temong where the case study is conducted. The sizes of precast box culvert been installed at site are 2400 mm X 1000mm Box Culvert special design 6.36m backfilling. The project, which consists about 57 units of precast box culvert at CM35 been installed along this crossing highway and the problem was appeared after few months from its execution. From investigation about 11 units of the box culvert failed and others units found that fine crack occur. A complete investigation work was taken to determine the causes and a proper repair process was carried out to solve the problem and to ensure those precast box culvert are satisfied the safety requirements.



Figure 1.1: Highway in Malaysia

(Source: MTD Prime Sdn. Bhd)

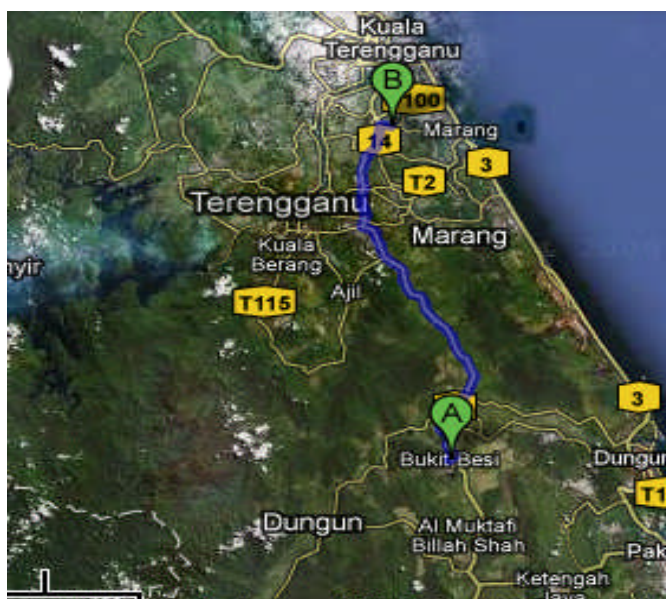


Figure 1.2: Location of the Site
(Source: MTD Prime Sdn. Bhd)

1.3 IMPORTANCE OF STUDY

This study deals with the causes of failure precast of box culvert. The investigation process and evaluation provide some useful information that may help those who face similar situation for constructing the crossing highway or the production of precast structure. For this case study, the report produced to the client to provide them some useful information whether the problems are due to construction consequences or design error. Faults in design or in construction stage also may cause damage in the box culvert structures. The analyzed of data gathered from testing and observation of precast box culvert was to identify whether the problem come from manufacturing process or during construction phase.

At the same time, the external factors such as water pressure effect , movement of soil can contribute to the damage of these structures. The defects that present in any one particular component in a box culvert can extend and weaken the box culvert to resist the loads. The condition of box culvert may become worse if the failure occurred in vital member and it will make the box culvert totally collapse.

1.4 PROBLEM STATEMENT

Cracks of precast box culvert have arises due to improper quality of materials, incorrect specifications, faulty design, and mistakes in construction process or extreme environmental conditions. They may affect appearance only, or they may indicate significant structural distress or a lack of durability. The problem of precast box culvert becomes a common issue that may affect the safety of the road users. 11 units of the precast box culvert found that there are numerous occurrences of crack formation throughout the culvert wall and lid. Investigation and in-situ testing are needed to evaluate the root cause of crack problems.

1.5 AIM AND RESEARCH OBJECTIVE

The aim of this study is to investigate crack in precast box culvert with the objectives as follows:-

- i. To identify the problem occur in box culvert structures.
- ii. To find the root causes of the problem in the culvert structures.

1.6 SCOPE OF STUDY

The scopes of work for this research are as follows:-

- i. Conduct the Non Destructive Test that involve :
 - Visual survey
 - Carry out scanning of steel bars in concrete using the Hilti PS 200 Ferrosan System from location 16 to 47 as attached in the Appendix A.
- ii. Conduct the Destructive Test which involved:-
 - 100 mm diameter concrete core extraction using hand drilling
 - Concrete density measurement.
 - Concrete compressive tests.
- iii. Evaluation and analyzed result based on site data compared with manufacturer specification
- iv. To find out the risk of failure is being considered as culvert material selection criteria, design or due to construction phase.
- v. Documentation of the finding in the final report.

1.7 Thesis Layout

The dissertation is divided six stages as follow:

Stage 1 – Identify Problem of Statement

This stage involves a problem statement on the status study of basic and crack problems of precast box culvert.

Stage 2 – Identify objective and scopes of research

Based on stage 1, the objectives and scopes of research were determined in order to carry out the research most suitable site for the study.

Stage 3 – Literature review

This stage involves a literature review on the previous research study of the crack problems in precast box culvert.

Stage 4 – Case study (Laboratory test / Analytical work)

Based on findings in stage 1 and 2, reconnaissance surveys were carried out in order to locate the most suitable site for the study. The selection will take consideration sites with failures box culvert. In this case studies of failure box culvert was located at East Coast Highway Project Phase II – Bukit Besi to Bukit Payung, Kuala Telemong, Terengganu (refer to **Figure 1.2**). After the study carry out at the selected site, preparation of report which include a site plan, layout plans and results. Based on the report important factors have to determine, the factor that affecting the crack of precast box culvert at the site.

Stage 5 – Data compilation and Interpretation

Data of result from the laboratory test was compiled and been interpreted to get a satisfactory result. The conclusion and root cause can be determined according to the result.

Stage 6 – Report writing and submission

It is anticipated that the thesis will comprise the following chapters;

- I. Introduction
- II. Literature reviews
- III. Methodology
- IV. Analysis and result
- V. Conclusion and recommendation
- VI. Reference