

ANALYSIS OF REINFORCEMENT OF HIGHWAY BRIDGE FLOOR SLABS WITH STEEL PLATE BONDING METHOD

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ABSTRACT

Toll Road experienced structural fractures in almost all bridge floor plates. The purpose of this paper is to identify and measure the crack depth with a Portable Ultrasonic Non Destructive Digital Indicating Tester tool, then determine the required strengthening model by calculating deflection on the bridge floor plate. The research method with direct survey on the bridge that occurred cracking by measuring cracks and applying reinforcement with the Steel Plate Bonding method. To find the deflection and stress on the bridge element, the load test is carried out before and after reinforcement. The results showed that steel plate bonding reinforcement on the concrete floor structure could reduce the deflection that occurred at 157.95-420.00% from the initial deflection and reduce the reinforcement stress by 181.82% - 267.74%.

Keywords: *Steel plate bonding, epoxy resins, strengthened, loading test, slab on pile.*

INTRODUCTION

In today's rapidly developing technological era, many new technologies have emerged to facilitate and assist in doing a job (Azis et al., 2021). Likewise with the toll road construction process, it must be with a very careful concept and preparation, but this research will not discuss how to make or design a toll road structure but more maintenance of the toll road. In the structure of the Toll Road reinforced concrete slab on pile bridge where the slab on pile type structure experiences structural crack damage to the bridge floor plate element. Cases of damage to the bridge floor plate are very likely to occur cracks that continue and can lead to bridge collapse if no immediate anticipation is made on the concrete bridge floor plate. To anticipate the collapse of the bridge floor plate, it is necessary to repair and strengthen the structure.

METHODOLOGY

In carrying out research work and evaluating bridge conditions the method used is descriptive. Descriptive method is by collecting, classifying, analyzing and narrating data so that final results can be obtained that can describe the conditions that exist or occur in the field.

Data Collection Method

In determining the condition of the bridge, data collection is needed so that accurate data is obtained. Primary and secondary data are needed to make it easier to evaluate the condition of the bridge. The primary and secondary data can be obtained as follows:

a. Primary data

Primary data is obtained from analyzing the specifications that have been made from the material items used in this reinforcement and obtained from PT. CITRA MARGA NUSAPHALA PERSADA, Tbk as the building owner.

b. Secondary data

Secondary data obtained from literature studies, this method is carried out to obtain theories, concepts, variables from notes, books, journals and so on to support and strengthen this research.

Preliminary Survey

Preliminary survey is the initial stage of work implementation. The activities carried out in this preliminary survey are:

Institutional survey

Institutional survey to obtain preliminary data on the bridge to be studied such as As-Built Drawing (executed drawings) and information about the state of the bridge.

The Ir. Wiyoto Wiyono, MSc. toll road is grouped into 2 areas, namely:

1. Ruas North-South Link Cawang - Tanjung Priok
2. Ruas Harbour Road Tanjung Priok-Jembatan Tiga-Pluit.

THEORETICAL FOUNDATION**Bridge Principle**

The bridge is an important structure in road infrastructure that serves to connect a road section that is cut off due to an obstacle. These obstacles are usually rivers, ravines, valleys, and lakes. Bridges are often a critical component in road infrastructure because they determine the maximum load that can be passed by the road section (Hadi & Leo, 2018).

Definition of Bridge

A bridge is a construction structure that serves to connect 2 parts of the road that are cut off by obstacles such as deep valleys, river channels, irrigation and disposal channels. Bridge construction must be planned in accordance with transportation demands, both in terms of speed, comfort, and safety (Ghello et al., 2020).

Construction Management

Construction Project Management states that construction projects have unique characteristics that are not repeated. The process that occurs in one project will not be repeated in another project (Tama et al., 2020).

Primary Load

Dead load, Live load, Shock load, Force due to ground pressure (Tama et al., 2020), Primary load is the load that is the main load in the calculation of stress in every bridge design (Budiwirawan & Pangestuti, 2010).

Concrete

Concrete is a mixture of cement, gravel and sand aggregates in a certain ratio to produce a certain strength. In accordance with the nature of concrete in construction, resistant to compression, concrete construction is more widely used as a distribution of compressive loads. Until now and in the future, reinforced concrete will still be the most important building material (Pujantara, 2014).

RESULTS AND DISCUSSION

Crack Depth Testing

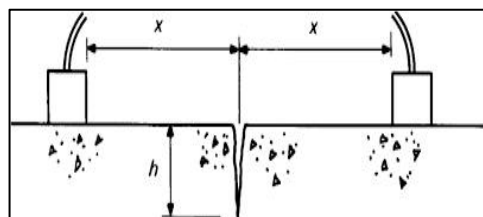
The test method carried out with the PUNDIT tool is developed based on the principle that the speed of propagation of waves through a solid medium depends on the elastic properties of the solid medium. If used properly and correctly, this tool can provide a lot of information about the condition of the surface or the inside of the concrete. This tool can also indirectly provide information about the compressive strength of concrete, if the relationship between the elastic properties of a solid material and its compressive strength is known.

This tool basically consists of a wave signal generator, transducer sender (transmitter) and transducer receiver (receiver). If the path length (distance between transmitter and receiver) is known, then the speed of propagation of the waves can be calculated. The standard ultrasonic testing method can be found in BS 4408 pt.5 or ASTM C 597.

The concrete strength of structural elements is very important, because a structure demands sufficient concrete strength, in order to work together with reinforcing steel as a reinforced concrete. Cavities and cracks in the structure need to be identified, as these can affect the long term load bearing capability of the structure.

Ultrasonic wave pulses cannot pass through air, so the distance traveled becomes longer, so that cracks and voids can be detected. This can affect the structure in carrying long-term loads. If the crack is filled with water, it cannot be detected, but only shows a lower propagation speed compared to its surroundings. Crack depth can be obtained by indirect testing, with the transducer placed an equal distance from the crack.

The location of the cavity can be detected by direct testing of the area of doubt, by taking data in several places. How to determine the depth of the crack can be seen in the figure below



How to determine crack depth

Concrete testing with ultrasonic waves is carried out to determine the density of the concrete surface. Concrete density testing with ultrasonic waves (PUNDIT) is carried out on concrete elements.

Before starting the crack depth examination using the UPV/PUNDIT tool, a visual examination was first carried out to determine the location of the crack points on the bridge floor slab. From the visual inspection, the distribution of crack patterns can be seen in Figure 3 below.



Figure 3. Distribution of crack patterns

Furthermore, the crack depth was examined using the UPV / PUNDIT tool which was spread on the cracked bridge floor plate, both before the epoxy resin injection Figure 4. and after the epoxy resin injection as shown in Figure 5. below..



Image Crack depth check before injection.



Figure Inspection of crack depth after injection

From the inspection data using the UPV/PUNDIT tool before and after epoxy resin injection work, it can be seen that the depth of cracks at the location of the floor slab to be injected and reinforced with Steel Plate Bonding.

CONCLUSIONS

The results of visual observations found cracks almost throughout the bridge floor slab and the results of the crack depth test conducted with the tool (PUNDIT) detected crack depth between 6.4 cm - 15.5 cm with crack width > 0.2

mm and has exceeded the thickness of the concrete blanket 5.00 cm so that it can be declared structural cracking. After injection with epoxy resin the crack depth decreased to between 0.4 - 0.9 cm.

Of the 4 existing reinforcements Steel Plate Bonding is the choice for reinforcement of slab on pile floor slabs because the reinforcement method with Steel Plate Bonding has high enough strength, fatigue resistance and is able to withstand loads in all directions.

From the 3 loading combinations carried out, the following can be obtained: Combination 1 (truck load in the slow lane), namely the maximum deflection at mid-span has improved behavior by 237.84%. The maximum stress in the bottom fiber reinforcement has improved behavior by 181.82%. Combination 2 (truck load in fast lane): the maximum deflection at mid-span experienced an improved behavior of 420.00%. The maximum stress in the bottom fiber reinforcement has improved behavior by 265.38%.

Furthermore, combination 3 (truck load in slow and fast lanes): the maximum deflection at mid-span experienced an improved behavior of 157.95%. The maximum stress in the bottom fiber reinforcement experienced an improved behavior of 267.74%. It can be concluded that by reinforcing with the Steel Plate Bonding method, the deflection that occurs in the slab on pile structure is reduced by 157.95% - 420.00%.

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