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Redesign of Plans for the Rehabilitation of Over-Flow Bridge at Barangay Cansan, Cabagan, Isabela

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Abstract **- Bridge is one of the most useful transportation structures that connect places and provide access for people to travel from one place to another. For bridges, lack of proper technical design and maintenance can lead to the sudden closure of transportation link or, far worse, a collapse that result in lost lives and significant decline in regional economic productivity.**

The study focused on the redesign of plans for the rehabilitation of over-flow bridge at Barangay Cansan, Cabagan, Isabela connecting the Municipalities of Cabagan and Sto. Tomas. The descriptive method of research was used in the study. The purposive sampling technique was utilized to select the respondents. Researchers-made questionnaires were used as survey tools for the administration of the study to 120 respondents from the Municipalities of Cabagan and Sto. Tomas, Isabela, Department of Public Works and Highways (DPWH), Local Government Official, and Community Leaders as the stakeholders and who are aware of the development and management of the over-flow bridge facility.

Statistical treatments were used to analyze the data and further validated through inspection or investigation of the existing structure. As a result, the respondents were unsatisfied with the physical features, serviceability, safety and maintenance of the existing facility. Thus, it is hereby concluded that there is a need for the improvement of the existing facility. In coordination with the concerned stakeholders, a redesigned plan is produced as basis for the rehabilitation of the existing over-flow bridge and for their decision making.

Keywords-Bridge, Redesign, Plans, Rehabilitation, Productivity

1.0. INTRODUCTION

Nowadays, with continuous increasing population, business progress, and urbanization happening in the country, transportation structure demand is also rising. Transportation is important since it enables trade between people. Bridge is one of the most useful transportation structures that give passage to people to go to other places and connect many places in one country. It provides crucial access between regions and cities, linking workers to jobs, goods to markets and people to essential services (Freeby, G. A., 2012)[1].

Most of the bridges in the Philippines have defects due to lack of maintenance procedure and not quite budgeted compared to technology that always maintained and developed. Infrastructure must always develop and maintain to have a good condition and quality. Defect structure must be improved or repaired to give more benefit to the people. Lack of maintenance for bridges can lead to sudden closure of a critical transportation that result in loss of lives and a significant decline in regional economic productivity. Safety of the public is one of the considered aspects in constructing structures. Thus, deficient bridges should have a significant maintenance, rehabilitation or replacement.

Cabagan – Sto.Tomas Over–Flow Bridge was built on May 2008, which connects the Municipalities of Cabagan, Isabela and Sto. Tomas, Isabela. The overflow-bridge was constructed between Barangay Cansan in Cabagan and Barangay Bagutari in Sto. Tomas crossing the Cagayan River to provide service to people going to other town especially for the farmers in bringing their agricultural products to the market centers.

Figure 1: Cabagan-Sto. Tomas Over-Flow Bridge

The bridge was designed into overflow type concrete bridge consisting of 21 spans having 15 meters per span or a total length of 315 linear meters with a roadway of 4 meters. They used concrete bored piles as piers and foundations, concrete girders and concrete floor slab. The bridge was implemented in six phases, the first two phases under the DPWH Region 2 and the last four phases by the DPWH Isabela 1st District Office (Brody, J. E., 2008)[2].

The bridge is very useful to the town of Sto. Tomas and neighboring towns like Delfin Albano which are surrounded by river and could only get to other town only by boat or by using the overflow bridge. The

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completion of the bridge has brought a tremendous impact to the economy of Cabagan and Sto. Tomas. It also ended the struggles and suffering of people crossing the river through boat or barge. However, the bridge is not passable during heavy rains or typhoon strikes due to over flow of the water from the river. Moreover, after three years since the construction of the bridge, the super typhoon that occurred last October 2011 brought damaged to the bridge. Technically wise, the bridge is deteriorating which is dangerous to the passers.

The researcher aims to determine, analyze and investigate the present status of the Cabagan-Sto. Tomas over-flow bridge and how it affects the commuters, pedestrians and the residents near the bridge. The researcher used descriptive research and engineering survey to identify solutions to the problems in the rehabilitation of said bridge.

Thus, this study provides information that will assist the concerned government and private groups, and the community in the decision making with regard to the development of the facility.

2.0. REVIEW OF RELATED LITERATURES

According to the Provincial Office of the DPWH at Ilagan, Isabela, Cabagan - Sto.Tomas, the existing bridge was constructed three years ago and was designed as an over-flow bridge due to budget shortage. Since the bridge is the major means of transportation for the residents to access in neighboring towns, the government decided to temporarily build the said structure (Medestomas, R. V., et al, 2011)[3].

A bridge is defined as a structure, including supports, erected over a depression or an obstruction, such as water, highway, or railway, having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between under copings of abutments, or spring lines or arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between opening is less than one-half of the smaller connecting opening, (Bridge Inspection Maintenance and Repair, 1994)[4].

Condition assessment and evaluation of existing bridges may be prompted by changes in traffic patterns; concern about faulty building materials or construction methods; discovery of a design/construction error after the structure is in service; concern about deterioration discovered during routine inspection; and damage following extreme load events. A condition assessment may be conducted to develop a bridge load rating, confirm an existing load rating, increase a load rating for future traffic, or determine whether the bridge must be posted in the interest of public safety. (Condition Assessment of existing bridge structures, 2009)[5].

According to Lee G.C., et al (2008)[6], bridge failure may be defined as loss of a structural component, loss of a bridge's basic functionality, a catastrophic bridge collapse, or any damage condition in between. A bridge can fail due to a variety of single or combination of reasons including material imperfection or aging, overload, insufficient capacity, construction error or improper maintenance. Lessons can be learned through proper studies of bridge failures. Similar to reconnaissance studies of damaged or collapsed structures after a natural disaster, design guidelines can be improved through better understanding of the cause and mechanism of failure.

In the construction of roads and bridges, pedestrians need to be accommodated and suitable sidewalks must be provided. The minimum clear sidewalk width should normally be 5 ft. In no case should a sidewalk not protected by a traffic railing be less than 3 ft. 6 in. wide. The need for sidewalks usually occurs in an urban area where a depressed highway crosses under a city street or on frontage road bridges. A suitable barrier rail or combination railing should be provided, if required. (Roadway Design Manual, 3rd Edition, 2010)[7].

An important dimension of transport infrastructure is the network of roads that provide a physical link to various communities in urban and rural areas with outside markets. A good network of roads at the local level is indispensable in the timely movement of people and transport of goods with low transaction costs. Good local road infrastructure is correlated not only with local economic growth but also instrumental with poverty reduction as shown by several studies. In a study of a rural fishing community in the Philippines characterized by poor transport conditions and poor accessibility to major markets, demonstrated that the improvement of road accessibility leads to considerable benefits to the community, (Gilberto, L.M., 2011)[8].

3.0. METHODOLOGY

The descriptive research method, engineering survey, and inspection were used in the study. The normative survey of descriptive research was used in relation to the stakeholders' perceptions on the assessment of the existing over-flow bridge. Normative survey establishes norms for abilities, performances, beliefs and attitudes on samples of people of different ages, gender and other classifications. The researcher used the purposive sampling which samples were those who are aware of the existing over-flow bridge and are free to answer questionnaires relative to the condition and effect of the said facility. Engineering survey and inspection of the facility were conducted to further investigate and assess its condition.

Respondents of the Study

The 120 respondents of the study composed of the residents of the municipalities of Cabagan and Sto. Tomas, Isabela, personnel from the DPWH and employees from the concerned local government units and community leaders.

According to Broto, A. S. (2006)[9] on the book "Statistic made Simple" the computation of the sample size relative to the population has the formula.

$$n = \frac{N}{1+Ne^2}$$

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Where:

e = margin of error
N = the population size
n = sample size

Thus, for the samples from the two municipalities, the result below provides the minimum sample size:

$$n = \frac{75,987}{1 + 75,987(.10)^2}$$

n = 99.87 or 100

However, since it is very important to involve the concerned agencies, the researcher decided to have one hundred fifteen respondents to ensure reliability of information.

Instruments Used

The researcher's made-questionnaires for respondents' perception relative to the condition and effect of the existing over-flow bridge were used in the study. Also, the researcher used other engineering instruments during the inspection in order to investigate the physical features of the structure.

Data Gathering Procedures

The questionnaires were administered to one hundred fifteen respondents. The data were then classified, tallied, tabulated and prepared for statistical treatment and analysis. Other information during the inspection of the over-flow bridge was noted for analysis and interpretation.

Statistical Treatment of Data

After gathering and collecting the data, the researchers organized and analyzed information by using tabulation and bar graph.

Gender	Frequency	Percentage (%)
Male	76	63.33
Female	44	36.67
Total	**120**	**100.00**

Weighted Mean. The formula to compute the weighted mean is,

$$\overline{X} = \frac{\sum Fx}{N}$$

Where:

$\overline{X}$ = Weighted Mean
$\sum$ Fx = Summation of the elements and its weight.
N = Number of respondents.

Below is the rating scale used in the study,
4.50 – 5.00 = Very Satisfied
3.50 – 4.49 = Satisfied
2.50 – 3.49 = Neutral
1.50 – 2.49 = Unsatisfied
1.00 – 1.49 = Very Unsatisfied

4.0. RESULTS AND DISCUSSIONS

This covers the analysis and interpretation of data relative to the perceptions of the respondents on the condition and effect of the existing over-flow bridge.

1.0. Profile of the Respondents

Age	Frequency	Percentage (%)
50 – Above	17	14.17
41 – 50	13	10.83
31 – 40	45	37.50
21 – 30	35	29.17
15 – 20	10	08.33
Total	**120**	**100.00**

1.1. Age

Table 1
Frequency Distribution of Respondents Based on Age

Table 1 shows the frequency distribution of respondents based on age. It reveals that age bracket of 31-40 has the highest frequency with a percentage of 36.67 seconded by age bracket 21-30. The age bracket 15-20 got the lowest frequency of 10, equivalent to 8.33%.

Below is the graphical representation of the frequency distribution of respondents based on age.

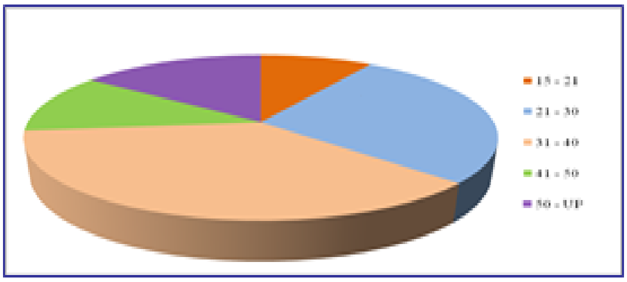

Figure 1: Graph of Frequency Distribution of Respondents Based on Age

1.2. Gender

Table 2
Frequency Distribution of Respondents Based on Gender

Table 2 shows the frequency distribution of respondents based on gender. It can be seen that female dominants the respondents with a frequency of 44, equivalent to 36.67%, while the male got the frequency of 76 with a percentage of 63.33.

Below is the graphical representation of the frequency distribution of respondents based on gender.

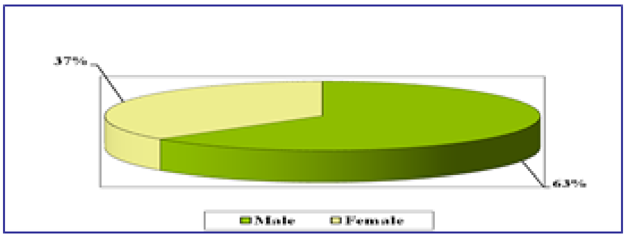

Figure 2: Graph of Frequency Distribution of Respondents Based on Gender

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2.0. Perceptions of Respondents on the Physical Features of the Over-Flow Bridge

Table 3 shows the tabulated data on the perceptions of the respondents regarding the physical features of the over-flow bridge.

Table 3
Perceptions of the Respondents on the Physical Features of the Over-Flow Bridge

Parameters	Mean	Verbal Interpretation
1. Height difference of the bridge from the water level during flooding	2.08	Unsatisfied
2. Width of the bridge	2.18	Unsatisfied
3. Architectural design and painting of the bridge	2.12	Unsatisfied
4. Lighting materials and electrical wirings	1.69	Unsatisfied
5. Bridge railings	1.94	Unsatisfied
6. Road pavement of the bridge	2.02	Unsatisfied
7. Stability of bridge ends and foundation	2.15	Unsatisfied
Mean-Total	2.03	Unsatisfied

The respondents perceived that they are unsatisfied with all the physical features of the existing over-flow bridge with a mean-total of 2.03.

Below is the graphical representation of the perceptions of the respondents on the physical features of the over-flow bridge.

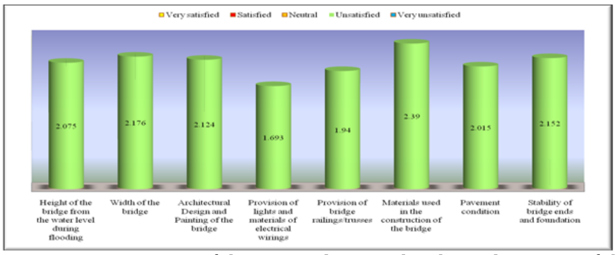

Figure 3: Perceptions of the Respondents on the Physical Features of the Over-Flow Bridge

3.0. Perceptions of Respondents on the Safety and Maintenance Measures to Sustain the Effective Use of the Over-Flow Bridge

Table 4 shows the perceptions of the respondents regarding the safety and maintenance measure to sustain the effective use of the bridge.

Parameters	Mean	Verbal Interpretation
1. Provision of safety signage including lane separator	1.95	Unsatisfied
2. Safety of pedestrian lanes	2.28	Unsatisfied
3. Cleanliness of the bridge and the surroundings	3.08	Neutral
4. Traffic flow control	2.73	Neutral
Mean-Total	2.51	Neutral

Table 4
Perceptions of Respondents on Safety and Maintenance Measures to Sustain the Effective Use of the Over-Flow Bridge

Table 4 implies that the respondents were neutral on safety and maintenance measures to sustain the effective use of the bridge with a mean-total of 2.51. However, in terms of the provision of safety signage including lane separator, and safety of pedestrian lanes, the respondents were not satisfied.

Below is the graphical representation of the perceptions of the respondents on the.

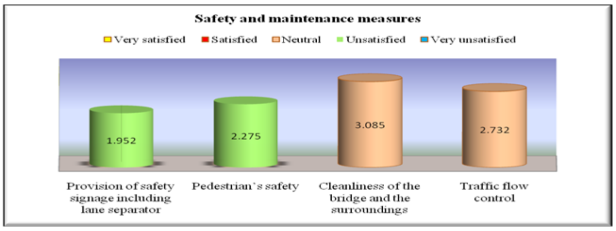

Figure 4: Perceptions of the Respondents on the Safety and Maintenance Measures of the Over-Flow Bridge

4.0. Result of Project Inspection/Validation

As per validation by the researcher during project inspection, the researcher noted the following status of the existing over-flow bridge.

4.1.1Deflected Span of the Bridge

Figure 5: Figure 3. Deflected Span of the Bridge

4.2. Damaged wheel guards as controlling part to prevent drawing of vehicles and motorists into the river.

Figure 6: Damage Wheel Guard and Reflectors

4.3. High slope of a road going down to the bridge that draws motorists into the river.

Figure 7: High Slope Road Connecting the Bridge

4.4. The width of the bridge cannot accommodate two four-wheeled vehicles at a time that caused traffic and delay to passers.

Figure 8: Width of the Existing Over-Flow Bridge
and Guardrail Sidewalks

4.5. Height of the bridge from the water level during flooding that caused danger to passers.

Figure 9: Height of the Existing Bridge from the Water

4.6. Water level during flooding

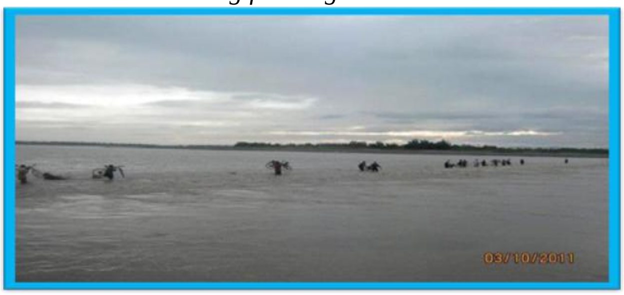

Figure 8. Water Level During Flooding

4.7. Absence of Lighting and Safety Signage

Figure 9. Absence of Lighting and Safety Signage

5.0. Problems Encountered by the Stakeholders in the Utilization and Maintenance of the Over-Flow Bridge

Based on the information gathered during the actual interview with the respondents, several accidents had happened in the said bridge due to its unfavorable condition such as the following:

1. Passers riding in motorcycles drawn to the river due to absence of railings.
2. Road traffic accidents happened due to lack of safety signage, maintenance and unimplemented traffic control regulations.
3. Several accidents happened in the deflected parts of the bridge.

6.0. Suggestions of the Stakeholders that Would Like to Put Forward to Resolve the Identified Problems

Based on the survey conducted, the respondents would like to recommend the following:

1. The DPWH and the LGUs of the Municipalities of Cabagan and Sto. Tomas should strictly follow and implement the standard requirements for bridge construction.
2. Proper management of the bridge by the LGUs.
3. Provide innovative design for an effective bridge as transportation facility.
4. Improve the existing over-flow bridge especially its height.
5. Provide safety measures with lighting facilities.

5. CONCLUSIONS

As a result of the findings, the researcher hereby concluded that the existing over-flow bridge should be rehabilitated as evidenced by the non-standard width, height of the bridge from the water level, and its architectural design; absence of lightings, railings, strong guardrails, painting and safety signage including lane separator and pedestrian lane; cracked pavement with potholes; unstable bridge foundation; the high slope connecting the bridge and the road causes several accidents; and absence of maintenance measures to sustain the effective use of the bridge.

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7.0. RECOMMENDATIONS

Based on the foregoing findings and conclusion, the researchers hereby recommend the rehabilitation of the over-flow bridge using the bridge design below which was prepared in coordination with the DPWH Office, Ilagan, Isabela, with a total cost of P203, 903.126.

7.1 Project Design

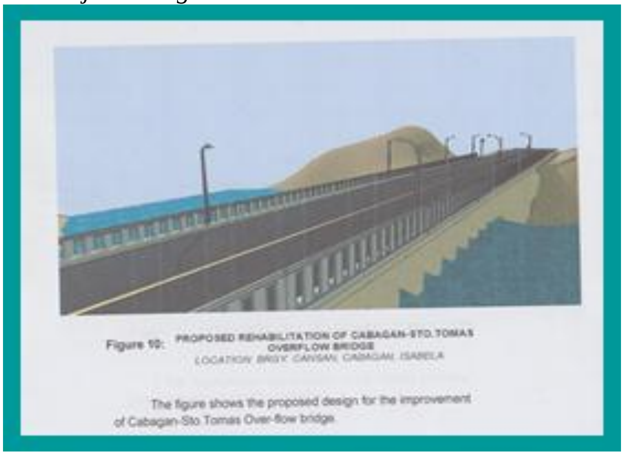

Figure 10: Proposed Rehabilitation of the Existing Over-Flow Bridge

7.2 Project Cost

Table 3. Estimate of Materials for Rehabilitation

ITEM NO.	DESCRIPTION	UNIT	TOTAL	UNIT COST	COST
				Php/unit	PESOS
F2	1.40m Ø BORED PILES	ln.M	420.00	128.08	3,011,744
F1	1.2m Ø BORED PILES	ln.M	2,220.00	282.487	20,807,070
SC1.6	STEEL CASING (t = 10 mm, Ø = 1.6m.)	LM	420.00	909.793	10,287,722
SC1.2	STEEL CASING (t = 10 mm, Ø = 1.2m.)	LM	2,220.00	879.000	78,584,200
RSBC	REINFORCING STEEL (GRADE 40)	kg	139.34	117	1,790,420
SC"A"	STRUCTURAL CONCRETE, CLASS "A" (fc'=28 MPA)	cu.m.	18.87	728.373	507,228
RCG1	RC GIRDER(1) L=4.4m	cu.m.	129.30	728.373	3,144,984
RCSW	RC SHEAR WALL	cu.m.	440.00	728.373	13,236,460
RCG2	RC GIRDER(2) L=8.0m	cu.m.	298.34	728.373	8,573,853
PSC-GB	PSC GIRDER BEAM, AASHTO TYPE V,1=24.80m	LN.M.	2,482.00	393.7	39,098,538
RC-D	C DECK PAVEMENT OF THE BRIDGE INCLUDING SIDEWALK	cu.m.	518.40	728.373	14,918,919
401	RC RAILING	LN.M.	66.00	107.222	493,706
TOTAL COST					₱ 203,903,126

Figure 11: Proposed Project Cost

7.3. Detailed Specifications

The following improvements shall be considered in the rehabilitation of the existing over-flow bridge.

Figure 12: Guardrail Improvement

Figure 13: Sidewalk Repair

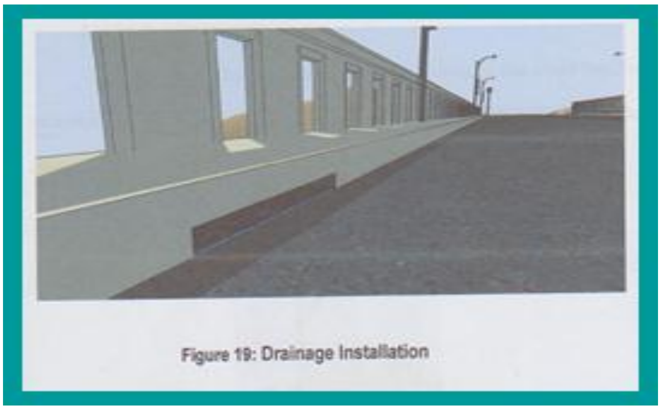

Figure 14: Drainage Installation

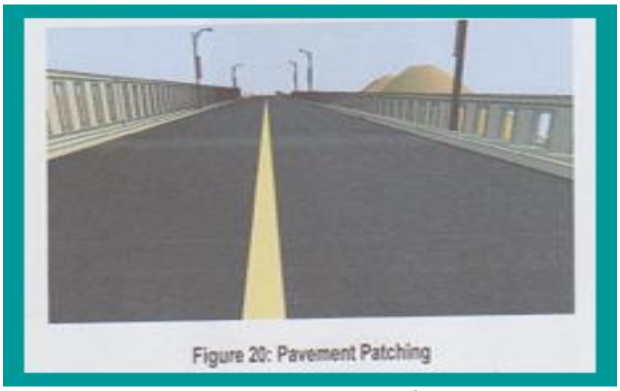

Figure 15: Pavement Patching

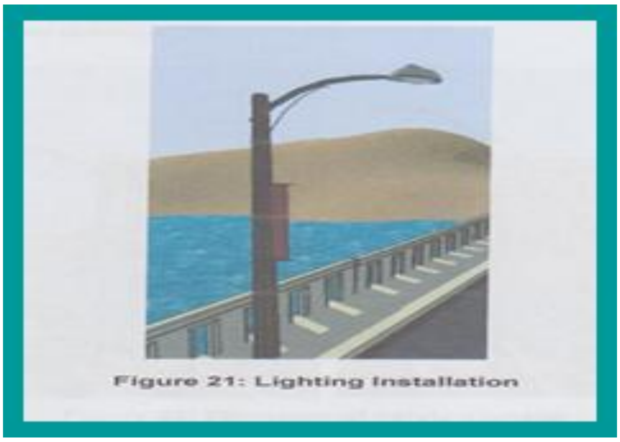

Figure 16: Lighting Installation

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Figure 17: Safety Signage

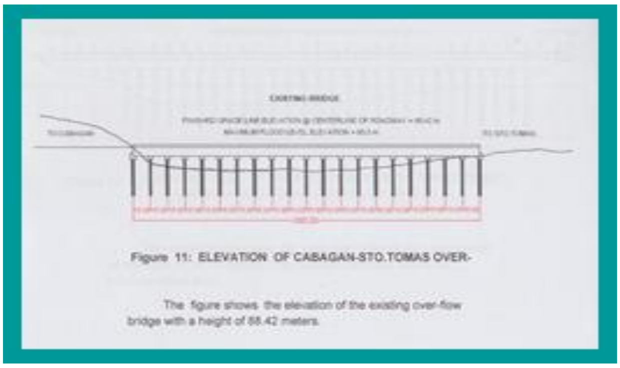

Figure 18: Elevation of Existing Over-Flow Bridge

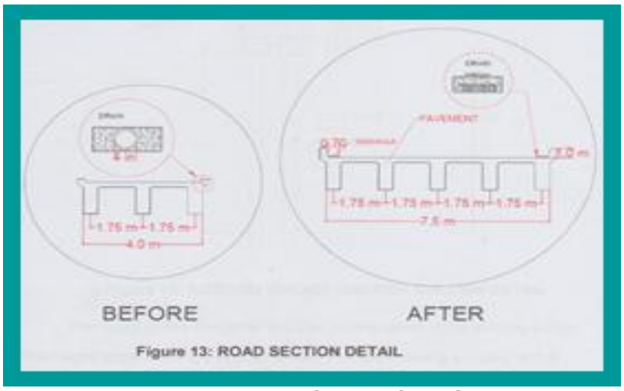

Figure 19: Road Sectional Detail

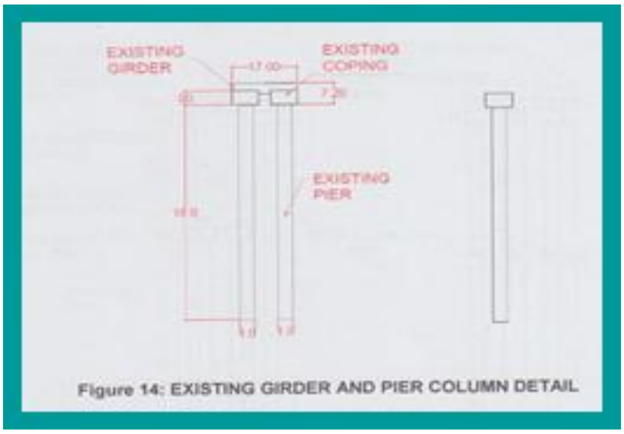

Figure 19: Existing Girder and Pier Column Detail

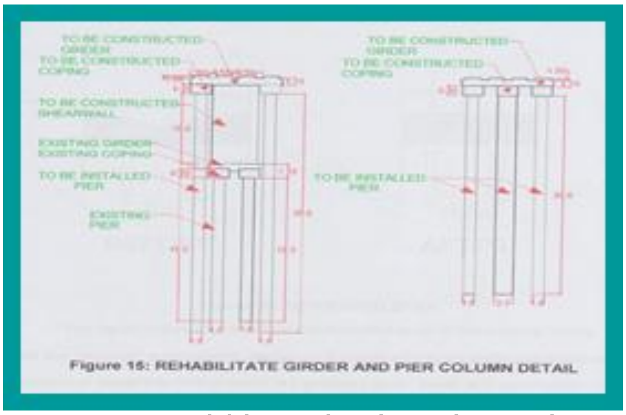

Figure 20: Rehabilitate Girder and Pier Column Detail

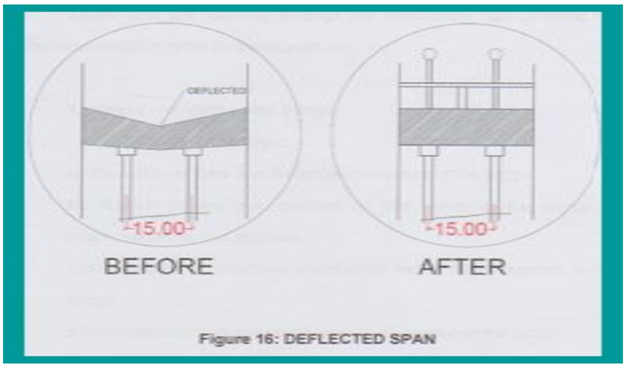

Figure 21: Deflected Span and Proposed Rehabilitation Design

Figure 22: Signage for Maintenance

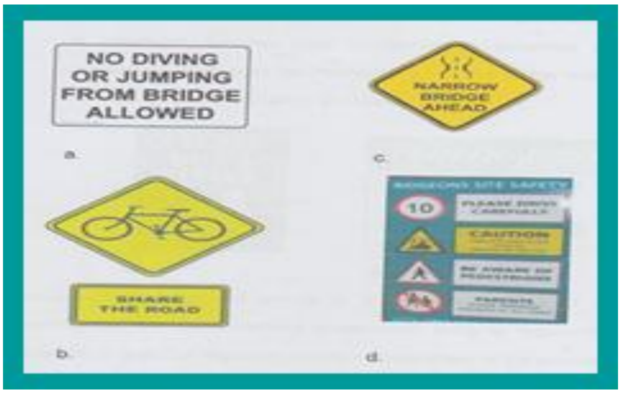

Figure 23: Signage for Safety Precautions

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