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Research Paper

Utilization Of Concrete Panels With Reinforced From Bamboo Petung Indonesia For Irrigation Water Gate

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ABSTRACT: *The cost of maintenance of irrigation infrastructure including water gates has absorbed substantial budget of APBN Directorate of Water Resources of PUPR Ministry, it is necessary to design water gate which is cheaper, easy to maintain and durable. One of them is to make a water gate from concrete panel with reinforcement from bamboo petung. After conducting laboratory study by making concrete panel with size 40 cm x 60 cm with water gate thickness of 3 cm and 3.5 cm, then variation of concrete quality used include K175, K. 225, K.300 and K.300 so obtained concrete panels with 8 different variations. From a series of experiments that have been done, the concrete structure in the form of panels with bamboo reinforcement can be used and able to withstand the hydrostatic load of water so it can be used as a plate on the water gate. The most optimal construction on effective thickness 3 cm with K.175 quality and bamboo reinforcement with a distance of 5 cm with the ability to hold eban up to 1080 kg.*
Keywords*: water, gate, concrete, structure , panel, bamboo, petung, reinforcement.*

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Notation :
K.175 = quality of concrete which has a compressive strength of 175 kg/cm2
K.225 = quality of concrete which has a compressive strength of 225 kg/cm2
K.300 = quality of concrete which has a compressive strength of 300 kg/cm2
P = tensile load of bamboo petung (N)
A = cross section of petung bamboo reinforcement (mm^2)
Ft //= Tensile strength of petung bamboo with its skin (MPa)
Fy = Tensile strength of petung bamboo without skin (MPa)
F = hydrostatic pressure (N)
h = high water in irrigation canals (m)
b= wide net sluice (m)
hp = hydrostatic pressure capture point (m)
C = petung bamboo compressive stress (Kg)
T = Tensile stress of petung bamboo (Kg)
E = Modulus of elasticity (kg/m2)
ε = strain (m)
σ = stress (kg)
Mn = Moment of concrete plate nominal (kgcm)

I. INTRODUCTION

The cost of maintenance of irrigation infrastructure has absorbed more than 20% of APBN budget of Directorate of Water Resources Ministry of PUPR since 2006 until 2017. Budget of maintenance cost one of them used for maintenance of main building, irrigation complementary building including water gate number

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(an average of about 400 gates in an irrigation system of 10,000 hectares). The maintenance budget of water gates includes: total replacement of water gates due to hard and stolen, partial replacement with welding, painting and gate lubrication. In the future, the design of water gates should be cheaper, easy to maintain and durable. One of them is to make a water gate of concrete panel with reinforcement from bamboo.

Along with improvements in technology and engineering, new structural systems obtained from concrete materials [1] are obtained. In the UK, the Modern Method of Construction (MMC) is defined as a technology that provides an efficient strategy for preparing more production with minimum time including prefabricated and off-site production methods using concrete materials [2]. Industrial building systems with prefabricated and widely used concepts are used on concrete materials [3-6]. Concrete application of precast one of them in the construction of wall building. Precast concrete walls provide excellent functionality for low to medium industrial and commercial buildings because they are relatively easy to manufacture, efficient, durable, and can obtain the desired quality.

A comprehensive and detailed investigation of the properties of bamboo, both against the stress, compression and bending values reported by Glen [7]. Mehra et al. [8], Narayana and Rahman [9], and Youssef [10], including investigations of water absorption and bamboo volume changes by Fang and Mehta [11], Fang and Fay [12] found it. Proper treatment of bamboo can significantly reduce the potential for water absorption during concrete in the curing process. Tests performed by Mentzinger and Plourde [13] on bamboo treated and treated bamboo showed substantial increases in bond strength between bamboo and concrete. Investigations are also reported on bamboo reinforced concrete structural elements, such as beams [7], slabs [14,15], columns [16] and walls [15].

The concrete wall system with bamboo reinforcement was developed by Vengala et al. [17] made of bamboo grids, bamboo columns and steel wire mesh. It was concluded that such wall types can maintain the most severe conditions that may be experienced during the life span of the structure. The design of various bamboo-based wall panels is discussed by Paudel [18] such as Quincha walls with bamboo stems, Grid wall systems etc. Widyowijatnoko [19] developed low-cost housing using reinforced prefabricated bamboo component consisting of bamboo reinforced concrete wall panel size 4 × 30 × 110 (cm3), reinforced concrete bamboo panel, reinforced bamboo gate frame and concrete beam steel boned. In studies looking at bamboo properties compared to steel, bamboo can increase the tensile strength of prefabricated panels [19].

The sluice construction with a width of 40 cm, 60 cm long and 3 cm and 3.5 cm capacity is planned to hold the water load under closed door operating conditions until partially open. The sluice is moved vertically up and down with a special lifting handlebar that only holds hydrostatic and hydrodynamic loads only. So at the floodgates on all sides of the arrival are assumed to be clasps while those on the upper and lower sides are assumed to be free. The pure material is made of concrete with a composition of sand, gravel and cement with reinforcement from petung bamboo. The choice of this material is because it is considered to be a step towards corrosion and easy to make. And the installation is easier when sharing water in the quarter irrigation channel section. The sluice gates from concrete panels with reinforced bamboo petung are designed to be waterproof, that is, there will be a coating of waterproof paint. So that in this study water seepage on the sluice was ignored

II. LABORATORY STUDY

This research is done by making concrete panel with size 40 cm x 60 cm with thickness 3 cm and 3.5 cm. Then the variations of concrete quality used include K175, K. 225, K.300 and K.300 to obtain concrete panel with 8 different variations. To obtain the quality of concrete that varies from K.175 to K.350, mix design in laboratory using cement, coral, sand and water is then tested for compressive strength after 28 days.

The bamboo used as reinforcement used bamboo that has been tested strong tensile. Bamboo used as a reinforcement has a width of 10 mm with a thickness of 5 mm, while the length of reinforcement follows the length and width of the gate. Bamboo reinforcement is mounted with a vertical or horizontal distance of 5 cm, then framed with iron size 6 mm, while the bond between the bamboo and iron is used wire with a diameter of 0.5 mm.

Fig 1. Selection of bamboo petung and how to mount reinforcement

The types of testing in this study are concrete tap test and water gate panel collapse test. The concrete press test is performed to know the value of compressive strength of the concrete cylinder. The materials prepared are cylindrical mold, Concrete Mixer, Porland cement, Sand, Gravel and Water. The water gate collapse test is conducted to determine the maximum collapse capacity of the concrete gate with the bamboo reinforcement. To do this, first need to make a water gate with concrete material and bamboo reinforcement with 2 variations of thickness of 3 cm and 3.5 cm thickness. Each thickness will be made K.175, K.225, K.250 and K.300, so that 8 samples will be tested for collapse.

III. RESULT AND DISCUSSION

3.1. RESULT OF BAMBOO TEST PETUNG

There are many kinds of bamboo, but of the hundreds of species, there are only four kinds that are considered important as the type of bamboo and are commonly marketed in Indonesia, namely bamboo petung, bamboo wulung, bamboo rope and bamboo duri [20]. Although lightweight bamboo has considerable strength, mechanical properties based on research conducted by Morisco [21] show that the tensile strength of bamboo is higher than steel yield stress. Strong adhesive bamboo apus, ori and wulung almost the same, which is about 0.6 MPa. Looking at the relationship between this adhesive strength and the bamboo shrinking nature, the bamboo flower shrink is the lowest compared to the three types of bamboo [21]. Therefore, based on the above description, in this study, bamboo petung has a tensile strength of bamboo [21] to 3100 kg / cm, while in research conducted for bamboo petung in Indonesia [23] obtained the results in table 1.

Table 1. Tensile strength test results bamboo petung

No	P (N)	A (mm^2)	ft // (MPa)	Fy (MPa)
1	3633,8	9	430,756	363,67
2	3114,1	9	346,011	245,57
3	2728,4	9	303,157	118,18

3.2. CALCULATION OF HYDROSTATIC PRESSURE ON GATE WATER

The calculation of hydrostatic pressure on the flood gate is calculated in full water conditions as high as the channel so as to obtain the maximum hydrostatic pressure value, with the following calculation:

- Theoretical width = 40 cm
- High gate (H) = 60 cm
- γ water = 10 kN / m^3
- Gate thickness (d) = 3 cm and 3.5 cm
- Quality of concrete = K175, K225, K250, K300
- γ concrete = 118.249 kg / m^2, 194.763 kg / m^2, 301.205 kg / m^2, 361,452 kg / m^2

The size of the water gate and the force diagram working on the water gate are presented in Figure 2. In determining the hydrostatic pressure acting on the panel section are :

$$F = \frac{1}{2}.\gamma.h^2.b$$

$$F = \frac{1}{2}.10.0.6^2.0.35$$

$$= 0.72 \text{ kN}$$

Safety factor

1.4 F = 1.4. 0.72

= 1.008 kN ≈ 100,8 kg

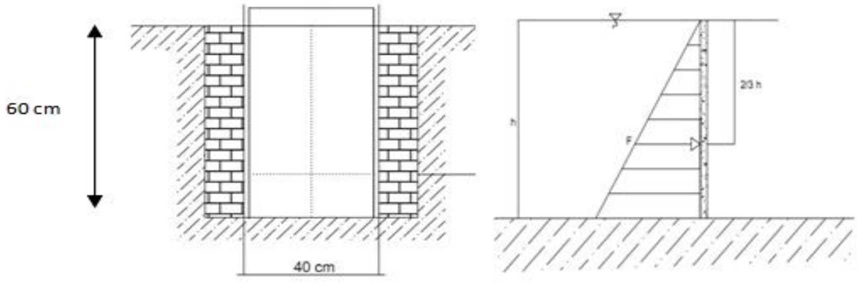

Fig 2. Distribution of forces acting on a concrete gate

In determining the hydrostatic pressure capture point is calculated as follows:

hp = ⅔ h
= ⅔. 0.6
= 0.4 m from the water surface

From the above calculations, the hydrostatic pressure of concrete panels is 100,8 kg and occurs at a depth of 0.4 m from the water surface.

3.3. CAPACITY TESTING COLLAPSE THE WATER GATE OF THE CONCRETE PANEL

In the test of the collapsed water gate capacity of the concrete panel, the maximum load collision test result on each panel is presented in table 5. From table 2 it is found that the panel with the highest collapse capacity is in panel H (3.5 cm thick and K300 concrete quality) of 2.295 kg.

Table 2. The burden of collapsing reinforced concrete bamboo concrete panels

Type Panel	P	As (cm^2)	Pu (kg)
A	0,0013	0,1414	1,080
B	0,0013	0,1414	2,160
C	0,0013	0,1414	2,195
D	0,0013	0,1414	2,295
E	0,0012	0,1414	2,080
F	0,0012	0,1414	2,194
G	0,0012	0,1414	2,215
H	0,0012	0,1414	2,350

The minimun collapse load on panel A (3 cm thick and K175 concrete quality) is 1.080 kg. Then the higher the quality of concrete and the thicker a water gate plate the higher the collapse capacity of the concrete panels, as well as the lower the quality of concrete and the thinner the water gate plate the lower the capacity of the concrete panel. In panel A the collapsed capacity is very low, this is not due to the low quality of concrete but caused because the concrete panel is too thin. So the thickness of a panel is a significant factor in determining the value of the collapse, as in panel E, although the quality is low but due to its thickness is adequate so as to withstand the load of higher collapse is 2.160 kg.

Fig 3. The process of making water gates from panels with reinforcement from bamboo

As for the value of the relationship between load and deflection in the concrete type A, B, C, D, E, F and G are presented in Figure 4.

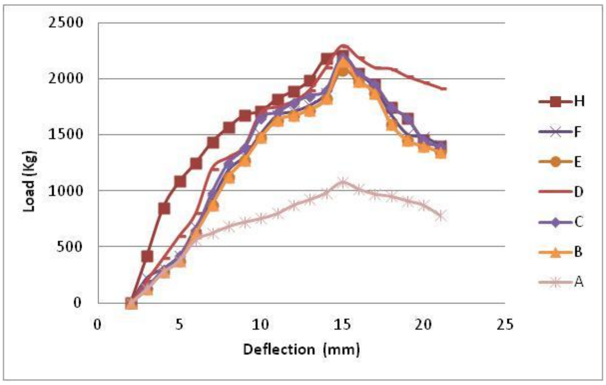

Fig 4. Graph the relationship between load and deflection in concrete types A, B, C, D, E, F and G.

Based on the previous calculation data then we can calculate the value of the compressive stress (C = 0.85, fc ', b), then the tensile bamboo strain (Tk = As. Fy), the moment arm Z = d (0.5xa) and nominal moment (Mn = T xZ). The nominal moment calculations on the water gate panel are presented in tables 3 and 4

Table 3. Result of Nominal Moment Composition of panel A (3 cm thick)

Type Panel	C (kg)	a (cm)	C (kg)	T (kg)	Z (cm)	Mn (kgcm)
A	3517,9077 a	0,0072	25,4729	25,4729	1,4964	38,1176
B	5794,1992 a	0,0043	25,4729	25,4729	1,4978	38,1533
C	8960,8487 a	0,0028	25,4729	25,4729	1,4986	38,1736
D	10753,1672 a	0,0023	25,4729	25,4729	1,4988	38,1787

In table 3, it can be seen that the nominal moment increases with the improvement of the quality of concrete, but on the water gate panel with the quality of K.250 and K.300 deviation is not too big. This shows the higher the quality of concrete the nominal moment value tends to be the same.

Table 4. Calculation Result of Nominal Moments of panel B (3.5 cm)

Type Panel	C (kg)	A (cm)	C (kg)	T (kg)	Z (cm)	Mn (kgcm)
E	3517,9077 a	0,0072	25,4729	25,4729	1,7464	44,4858
F	5794,1992 a	0,0043	25,4729	25,4729	1,7478	44,4815
G	8960,8487 a	0,0028	25,4729	25,4729	1,7486	44,4819
H	10753,1672 a	0,0023	25,4729	25,4729	1,7488	44,4870

In Table 4, the nominal moment value in the 3.5 cm panel has the same trend or trend as the 3 cm panel. The higher the quality of concrete then the nominal moment increases. But at the quality of K.250 and K.300 the deviation is equal to that of K, 175 to K.225. This shows that the thickness of the plate affects the distribution of nominal moment values on a plate, meaning that the thicker of a plate the nominal moment must still be taken into account.

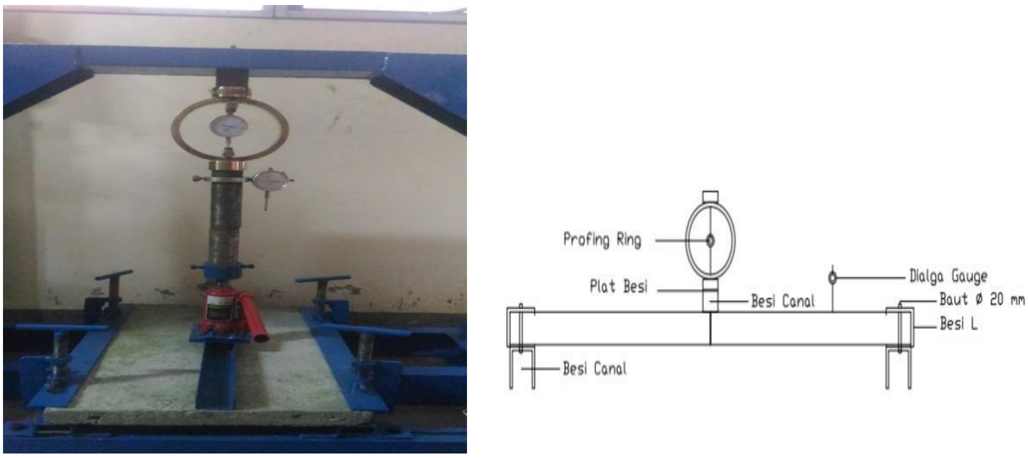

Fig 4. Diagram and Result of concrete water gate collapse test

In research on the use of reinforced concrete panel with bamboo reinforcement petung, it should be noted also the effect of stress and strain that occurred. Due to the reinforcement of bamboo petung different from steel reinforcement. In this calculation, it is assumed that the bamboo reinforcement also melts. Table calculation of stress and strain on the concrete panel with bamboo reinforcement is presented in table 5.

Table 5. Stress and strain of Concrete Panel with reinforced Bamboo Petung

Type Panel	E	ε (m)	σ (kg)
A	2×10^6	0.000757	1515.0163
B	2×10^6	0.000759	1516.3174
C	2×10^6	0.000755	1509.6190
D	2×10^6	0.000753	1508.5180
E	2×10^6	0.000764	1525.6458
F	2×10^6	0.000763	1521.3174
G	2×10^6	0.000760	1520.7291
H	2×10^6	0.000759	1519.2541

In table 5 we have described the stress-strain values that occur on the reinforced concrete bamboo panel. The strain value (σ) in panel F is the largest of all panel variations. Because panel F has a thickness of 3.5 cm and the lowest concrete quality is K175. From table 8 also obtained, that the stress and strain of concrete panels are influenced by panel thickness. The thicker the concrete panel, the greater the strain and strain value. But the higher the quality of concrete used, the value of stress and strain on the concrete panel decreased. This is because the thicker the panel, the value of the neutral lines and the effective height of the panel increases. Increasing the value of strain and strain of the panel result in the nature of the concrete panels more clay. Because of the circumstances, concrete sections will experience torn collapse. Where bamboo reinforcement has reached the melting point before reaching the limit strain (0.003) crushed concrete. Panels that experience something like this indicate that the panel is in an under-reinforced state.

To ensure the safety of concrete panels with bamboo reinforcement will be used for sluices, it is necessary to test to see whether the concrete panel test results are able to exceed the theoretical calculation results of hydrostatic pressure. Because the concrete panels will collapse when the collapse capacity value is below the hydrostatic pressure value. The capacity of each variation will be shown in table 6, as is the result of the tests conducted in this study.

Table 6. Comparison of Hydrostatic Pressure and Colapse Test Result

No	Type Panel	Hydrostatic Pressure p (kg)	Colapse Test Result, Pu (kg)	Conclusion Pu > P (kg)
1	A	770,9019	1,080	Qualify
2	B	770,9019	2,160	Qualify
3	C	770,9019	2,195	Qualify
4	D	770,9019	2,295	Qualify
5	E	770,9019	2,080	Qualify
6	F	770,9019	2,194	Qualify
7	G	770,9019	2,215	Qualify
8	H	770,9019	2,350	Qualify

In Table 6, there is a comparison between the hydrostatic pressure value of water and the results of the collapse test for all water gate variations. Since the panel test results are much larger than the hydrostatic pressure value of the water, the sluice gates of concrete panels with bamboo reinforcement can be used on tertiary water supply gates. Based on Table 6, the gate panels can be more efficient in terms of thickness and material type. This can be seen in concrete panel A, which has a collapse test value up to 1.080, meaning that with a hydrostatic pressure value there is a deviation of about 50%. One of the best options is to make gate panels lighter but size fixed. Keep the intentions tailored to the desired width of the gate. For water gates with width of 40 cm 3 cm thick need to be maintained, but for lighter can be developed lightweight concrete. Differences in quality and thickness create an increasing trend or trend. So for all variations of concrete panels in the planning of this study is to meet. The crash behavior image on the 8 variations of water gates is shown in figure 5 and figure 6.

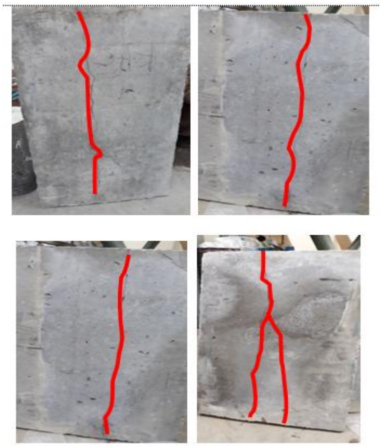

Fig 5. The cracking behavior of the concrete gate with a thickness of 3 cm

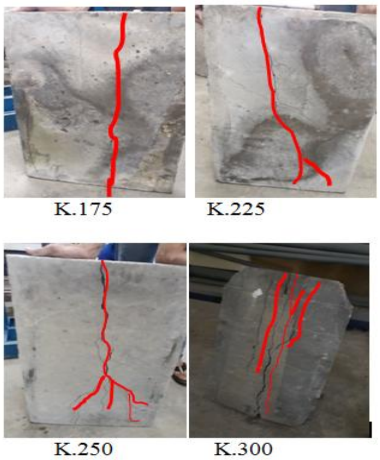

Fig 6. The cracking behavior of concrete slabs with a thickness of 3.5 cm

In Figs 6 and 7, it is seen that the crack pattern is influenced by the quality of concrete and the thickness of the concrete. The higher the quality of concrete cracks is smaller but the number of cracks more and more, which is very significant in the gate panel with a thickness of 3.5 cm. The cracks are increasing in K.300. As for the thickness of 3 cm the increment of new cracks seen on the concrete with the quality of K.300, while the quality of K.175, K.225 and K.250 has not been seen. This shows that the higher the quality of concrete there is a synergy of tensile and tensile strength so that the effect bebean be borne together, while at the low quality of the synergy of compressive strength and low tensile so that when the loading occurs rapid clogging occurs at the main node, as seen in crack behavior in concrete panel with a thickness of 3.5 cm. On the quality of K.175 cracks there is 1 fruit, K.225 cracking quality there are 2 pieces, K.250 cracking quality there are 3 pieces and the quality of K.300 cracks there are 4 pieces. After laboratory tests are then carried out field tests on the conditions of partial discharge and full conditions as presented in figs 8. The result is the sluice gates of concrete plates with bamboo reinforcement are sufficiently able to withstand hydrostatic loads of water.

a. partial discharge conditions b. full discharge conditions

Fig 8. Test the sluice field of concrete panels

IV. CONCLUSION

From a series of trials conducted on several types of concrete panels, the structure of concrete with bamboo reinforcement is able to withstand hydrostatic loads of water so that it can be used as construction on sluices.

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