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Flood handling system of Pucak Terate Bang Temple

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Abstract. Pucak Terate Bang temple is one of main in Bali located in Banjar Catu, Candikuning Village, Baturiti District, Tabanan Regency, precisely in Eka Karya Bedugul Botanical Garden area. This temple lies at an altitude of about 700 above sea level with the surrounding conditions still a natural forest. This temple is located under Lake Buyan and Lake Tamblingan which became the tip of Sungi river which eventually leads to Penet river in Cemagi Beach Badung regency. With the very high intensity at the end of 2016 until early 2017 precisely in January 2017 has caused the occurrence terrible floods and landslide in the area of Pucak Terate Bang and surrounding areas. These floods and landslides have caused severe damage to the temple and other areas of the Eka Karya Botanical Garden and other areas through which the upstream of Sungi river flows at the downstream.
The method of this research is descriptive quantitative and qualitative by conducting observation and direct measurement in the field done by hydrological analysis and hydraulic analysis and river capacity to get the formulation of flood handling required in accordance with Sungi river upstream characteristic in Terate Bang temple and surrounding area.
The results of the design rain analysis are as follows: R2 = 85.46 mm, R5 = 94.63 mm, R10 = 99.25 mm, R20 = 102.36 mm and R25 = 103.80 mm. Flood calculations show Q2 = 16.55 m3 / dt, Q5 = 18.32 m3 / dt, Q10 = 19.99 m3 / s, Q20 = 19.74 m3 / s and Q25 = 20.02 m3 / s. If this is related to the current channel capacity of Q25 of 20.02 m3 / st then the flood discharge is much larger with the capacity that can be accommodated by the channel. In addition to the small channel capacity another cause of flooding is the existence of a building built on the river channel. The recommended solution of this research is the making of 3 plunge buildings with an average width of 3 m with varied heights ranging from 2-3 m, channels with pre cast material in several variations, making a bridge with box culvert model with dimensions 2 x 2 m and making three variations of retaining wall

Keywords: Pura Pate Terate Bang, Flood, Technical Review

I. INTRODUCTION

The existence of Terate Bang Temple as main temple in Bali has significance for the people of Bali because it is one of the place of Hindu people in doing prayer. This temple is built on an area with a height of about 700 m right under Lake Buyan and Lake Tamblingan with the position of the temple is in the upstream Tukad river. Temple Location in Banjar Catu Candikuning Village, Baturiti District, Tabanan Regency is located within Eka Karya Botanical Gardens with the original condition of the hills (Galang Bali, 2016)

From the side of the arrangement, as generally temple in Bali, Terate Bang temple consists of Tri Mandala namely the main mandala (innards), madya mandala (middle) and Kanista Mandala or jaba side. Main mandala is a very sacred area and only related to spiritual and sacred ceremony (Galang Bali, 2016) There are four sacred buildings namely Pelinggih Gedong as a place of worship of Sang Hyang Brahma or Agni, Padmasana, Piyasan and Bale Penegtegan. To the west of the innards is Pelinggih Siwa (Ida Ratu Lingsir). And the Pelinggih Saka Pat Sari and genya toya Panca Maha Merta Mancawarna. To the northeast of the innards is Pelinggih Beji and other pelinggih. Pelinggih Shiva and Pura Beji are still

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directly related to Pura Luhur Pucak Terate Bang. The holy water for the tirta is taken from beji located in the northeastern part of this temple. While in the northwest there beji with water sulfur as many as five places called Maha Mertha Mancawarna. Below the place of the Tirta, there is Pelinggih Padmasana where worshiping Shiva. Water sulfur tirta that is usually requested by the people, especially the practitioners of medicine as medicine. The existence of this tirta seems very popular for the people of Bedugul. Not only that, people from various places in Bali often taking a holy water (tirta) in this place. (Galang Bali, 2016

Long droughts in 2015 and followed by long rains in 2016 have caused landslides in several cliffs including those in the upper area of Eka Karya botanical garden. With a very high rainfall intensity in January 2017 reaching over 215 mm / day (BMKG, 2017) has caused flooding and landslides from hills in Bukit Tapak on top of Pura continues to decline inland into the temple area. The condition of Pura Beji that is right in the river channel becomes the starting point of the waterlogging downstream and this creates a blockage so that the devastating flood that accompanied the flow of mud has overflowed and filled all parts of the temple and washed away some parts of the temple like Pura Beji, Bale Pesamuan, Penyengker, Apit Lawang and many other buildings. As a result of flooding not only affect the region of temple but resulted in the Eka Karya Botanical Gardens in the northwestern part of the breaking condition and erosion of some settlements residents in the west entrance of Eka Karya Botanical garden which is a groove upstream Sungi river.

Seeing the floods and the severe impacts it is necessary to do a comprehensive and strategic technical review so that similar problems do not occur in the future.

Departing from the background and problems can be formulated some things as follows:

A. What is the cause of flooding in Pucak Terate Bang temple ?
B. What is the magnitude of the design rain and the flood of 25-year rework plans in the upstream Sungi river groove?
C. How the concept of technical handling flood Pura Pate Terate Bang?

The purpose of this study is to obtain answers to the problems presented are:

A. Invented and mapped the cause of the flood at Pura Pate Terate Bang
B. Determine the amount of rain draft and flood design when re-25 years
C. Compiled the concept of handling of the flood that is comprehensive in Pura Terate Bang and surrounding areas

II. METHODOLOGY

Implementation of the research is conducted in the form of collecting information (primary and secondary data collection), field survey, problem analysis, and formulation of flood handling system.

- Surveys, field observations and data collection

Conducting a field survey to determine the current state of the river, including among others:

A. Map data collection, river length, watershed area, vegetation conditions within the watershed, topographic and geological conditions
B. Data flow system collection
C. Maximum daily rainfall data collection in Candikuning and surrounding areas with minimum data range in the last 10 years (BMKG, 2016)
D. Data collection at Eka Karya Botanical Garden, public work office and from Central government
E. Conducting interviews with the community around the temple , the affected communities around the west of the Candikuning mosque and the manager of Eka Karya botanical garden.

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F. Information gathering on the flood event that occurred

- Time and Location Research

The research time for the preparation of technical studies of flood handling Terate Bang temple for 6 months with the location of Terate Bang temple banjar Catu Village Candikunig Baturiti District Tabanan regency.

- Scope of Research

The scope of this study is as follows:

A. The study was conducted on the area of Pucak Terate Bang temple and surrounding
B. The flood discharges used are flood discharge with a 25 year re-birthday (Q25)
C. River flow is calculated based on steady flow uniform flow

- Data Sources Determination

The existence and source of the data would be a very important part in relation to the validity. With regard to data to be taken then the data source to be referred is as follows:

A. The maximum annual rainfall data for Singaraja statsiun is obtained from the Bali Meteorology, Climatology and Geophysics Agency III on Tuban Highway. Rainfall data series taken at least the last 10 years with the proposed proposed station is Candikuning rain station
B. River data obtained from Bali Penida river council Office of Public Works Complex Road Cok Agusng Tresna, Denpasar

Research Instruments

Instrument is completeness in doing research which very influence to result of a research Instruments required in this research include:

A. GPS
   Function: determines the coordinate position
B. Baseline Map of the river system
   Fungi: Determine flow system, length of watershed and broad watershed
C. Land use map
   Function: determines the coefficient of the drainage region in the hydrological analysis
D. Theodolite
   Function: to measure topography to get long and cross section
E. Land type map
   Function: This map is used to find out about the type of soil in the study area
F. Meter
   Function: for dimension measurement

- Data Analysis

Data analysis conducted in this research is as follows:

A. Hydrological analysis
   This analysis serves to obtain rainfall design, flood design and rain intensity in the study area (Sharin, 1990, Chow, 1987)
B. Capacity and hydraulics analysis
   This analysis serves to determine the capacity of the river
C. Socio-cultural and economic analysis
D. Analysis of flood handling system

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➢ Preliminary Research

Preliminary research was done some time after the devastating flood in Terate Bang Temple. Based on the results of interviews and river flow tracking and based on preliminary analysis obtained an early reference that is the occurrence of a very severe floods accompanied by landslides preceded by the occurrence of lumbering that occurred above the temple is in Bukit Tapak. Avalanches carrying mud and logs are carried downstream and clogging the narrow river passage in the Beji temple area. This condition causes water, mud and tree trunks to enter the temple area and cause floods with large mudflow spilling into the south.

III. RESULT AND DISCUSSION

➢ Hydrological Analysis

Hydrological analysis is conducted to know the amount of rain draft and flood design that occurred in the area Terate Bang Temple or Bedugul area. In this hydrological analysis, the required annual maximum rainfall data from the nearest rain stations in the rain tank area in the area of Pucak Terate Bang temple. (Gao 2003, Liu 2003, Linsley 1995)

➢ Design Rain

The design rain analysis is an analysis to determine which rain occurs in a given period with a certain probability of occurrence. The data of rainfall is data of rain station Bedugul with 24 series of observation data from 1993 until 2016 (Central Research,2000) Saharin 1990)

Rainfall design

No.	Period (year)	G	Rainfall Design (mm)
1	2	0.0954	85.46
2	5	0.8753	94.63
3	10	1.2406	99.25
4	20	1.4695	102.26
5	25	1.5839	103.8
6	50	1.7664	106.3
7	100	1.9284	108.58
8	200	2.0608	110.47
9	1000	2.323	114.32

Source : analysisis

Design Flood

The design flood calculation can be done using two approaches that is with the rational formula for the catchment area around 450 Ha and with the Nakayasu approach if more than the area. In this case the design flood calculation is done by the method of Nakayasu because the area of the catching area reaches 600 Ha. (Chow 1987)

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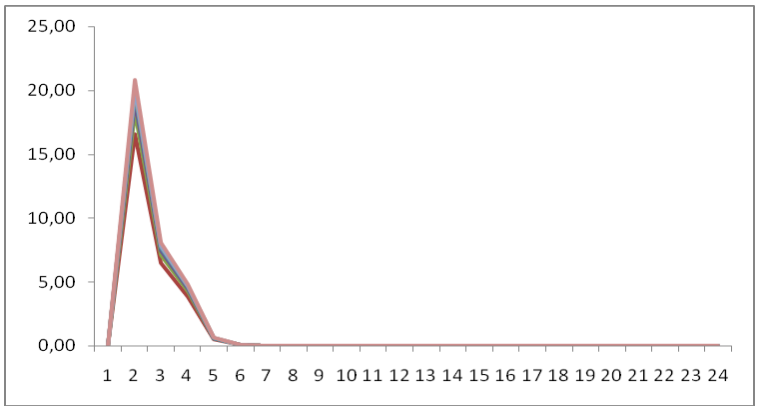

Fig 1 Flood Desingn

Capacity Analysis
Capacity analysis is carried out to determine the capacity or capacity of the existing channel or river. (Sharin 1990, Chow, 1987)
Q = A V
Q: channel capacity (m3/sec)
A: wet cross-sectional area (m2)
V: speed (m /sec)
From observations and measurements in the field obtained:
Average river width = 1.2 m
Average channel height = 0.6-0.8 m
Average slope = 0.02
The basic roughness and walls of the natural river (0.035)
Maximum capacity of water that can be missed is: 2.5 m3 /sec
B = 1.2
H = 0.8
A = 0.96
P = 2.8
R = 0.342857
S = 0.035
V = 2.609107
Q = 2.504742

From the calculation results show that the existing flood discharge is much greater than the existing tamping power

- Upper Sungi river Streaming System

Location Terate Bang temple is located in the upper watershed of Sungi river which tops its watershed in the hills above the temple as far as 600 to the north. Temple location flaved by two tributaries in the east and west. The problem is that the location of Pura is located at the confluence of the river.

- Flood Management System Terate Bang temple

Floods that occur in Terate Bang temple occurred at the beginning of 2017 precisely in January 2017 due to the existence of a very large overflow water accompanied by sediment pour into the river flow around

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beji temple. This condition is still added with water and avalanche that flows that occurred in the western part around Tirta Pingit temple. Very large water discharge accompanied by sediment material resulted in the capacity of existing river / channel can not accommodate the existing discharge. From the result of hydrological calculation, it is found that the discharge occured with 25 yearly (Q25) is 20.02 m3 / s while the maximum capacity of river or channel is 2.5 m3 /s. With this condition, the overflowing water overflows everywhere. Beji temple along with all the penyengker, Bale Bengong and Penyengker existing in Central Jaba carried away by the flood. Floods continue to flow downstream swept away the bridge crossing in the area of the Botanical Garden. Flood plains continue to flow downstream and erode buildings of several buildings and houses located west of the corn statue of Candikuning Village. As a result of this scour some homes have been scoured and drifted with water and two bridges are scoured.

- Flooding of Terate Bang Temple

Flooding of Terate Bang Temple is done by checking the current flow system. From the existing flow system is known that the flow of upstream Penet river on the east is very potential to cause flooding because the plot is right next to Beji temple. With the condition of the river located at a fairly steep elevation area (0.03) then the handling techniques carried out are as follows:

1. Waterfall Building

   The plunge structure is a structure made of stone pairs made at high differences between contours with other contours. Placement of the plunge building is prioritized on the elevation area around Beji temple. The number of plunge buildings required by 1 piece. The plunge building is made with a height of 3 m and its width is 1.2 x the width of the river.

2. Check Dam

   Check dam is a structure made of stone pairs mounted across the river in the Lower Beji teple and in the upper Beji temple.. The checkdam building is 3 meters high and 1.2 x wide by river.

3. Precast Channel (U-Ditch)

   Pre cast channels are created in multiple places with different dimensions to fit the discharge requirements.

4. Box culvert

   Box culvert made with dimensions of width 2 m and height 2 m placed on the junction of the drainage of coal

IV. CONCLUSION

From the discussion conducted related to flood handling system that occurred in Pura Terate Bang Pura Region can be concluded several things:

A. Floods that occur due to the extreme weather of rain in early 2016 that exceeds 100 mm / hour which triggers the occurrence of cliffs in the upstream that flows and meet the channels below. Other conditions that cause the occurrence of flooding is the existence of a Beji temple building built right in the river

B. The design rain analysis showed 2 year (R2) of 85.46 mm, R5 = 94.63 mm, R10 = 99.25 mm, R20 = 102.36 mm and R25 = 103.80 mm. The design flood analysis shows 2-year design floods (Q2) = 16.55 m3 /s, Q5 = 18.32 m3 /s, Q10 = 19,19 m3 / s, Q20 = 19,74 m3/s and Q25 = 20,02 m3 / s. Hydraulic analysis and channel capacity shows the capacity of existing channels with an average capacity of 2.5 m3 / s. This shows the capacity that is far below the design flood discharge that occurred.

C. Recommendations in bannjir handling that can be delivered are as follows:

- The plunge structure is a structure made of stone pairs made at high differences between contours with other contours. Placement of the plunge building is prioritized on the elevation area around

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Beji temple. The number of plunge buildings required by 1 piece. The plunge building is made with a height of 3 m and its width is 1.2 x the width of the river.

- Making Dam check
  Check dam is a structure made of stone pairs mounted across the river in the Lower Beji temple and in the upper Beji temple. The checkdam building is 3 meters high and 1.2 x wide by river.
- Precast Channel (U-Ditch)
  Pre cast channels are created in multiple places with different dimensions to fit the discharge requirements. U-ditch channels are made in type:
  Width of 2 m and height of 1.5 m with a length of 946 m
  Width 0.6 m and height 0.6 m with length 99 m
  Box culvert

Box culvert made with dimensions of width 2 m and height 3 m with width of 10.8 m placed on the junction of westward flow.

- Land retaining wall
  Retaining wall height 2 m with length 54,6 m
  Retaining wall height 3 m with length 336 m
  Retaining wall height 6 m two sides with length 130 m
  Retaining wall height 3 m two sides with length 500 m

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