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Flood Propogation

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Abstract

The catastrophic failure of the dam creates to a rapid changes of flow depth which causes a devastating damage in the cultivated land in the downstream of the dam. The precise calculation to its attenuation of the wave height is critical to the design of the protection work for the cultivated land of the downstream communities. Therefore, this topic is aimed to present an illustration the estimation of the open channel surges in the downstream river reaches.

***Keywords**: surge, dam, dike, river morphology*

1. Introduction

The unpredicted flood which generates waves in the river system had often toppled the edges of the field and inundated the whole area of the cultivated field. It is a real challenge to calculate the precise wave height in order to construct a dike around the field to protect their land. Again, the challenge is in obtaining a real flood hydrograph in such events as well as the various flood frequencies in the design of dike so that the flood wave cannot topple the protection work. However, the wave propagation and surge height for its attenuation to a required distance in to the field had to be calculated in order to construct the dike for the protection work.

2. Flood Protection work

The change of river morphology and its cause in eroding the bank during the flood event due to the construction of the river diversion structure for building hydropower project is needed to protect the cultivated land of the downstream communities. As we can see from the photograph that the original river course has been diverted and the new river course is very near to the cultivated land of the downstream communities. The land is subjected to each monsoon flood and needed a flood protection work. It is the objective of the project to design and construct the flood protection work for the increase level of the flood in the river reaches where there are chances of the flood venerable to the cultivated land. The design and construction of the protection work needs careful consideration of the flood hydrograph and the precise level of increased flood level in such events.

3. Assumption and utilization of the required data

3.1 Hydrological data of the river

The hydrological data was obtained form the government of Nepal, hydrological department. The data was processed and analyzed for preparing the hydrograph of the river. The hydrograph was utilized in calculating the various frequencies of floods. Then the desire flood was selected to assess the depth of the flood in the required river reach where the protection work is needed.

Also, a hydrograph of the disastrous event which was assumed when the poundage breaches out suddenly and the reservoir water draws down immediately.

During the design both of the cases had considered and the most critical case is presented in the report.

3.2 River cross sections

The cross sections of the river in various chainage had taken to estimate the width and the geometry of the river reaches. The river cross section defines the geometry of the river reaches so as to provide sizes of the protection work. This will give the various level of the protection work on such events.

3.3 River characteristic

The riverbed is assumed to be mobile and the scour depth of the flood in such events was estimated and the dike design is performed.

4. Design and Analysis

The detail calculation of the flood hydraulics is included in the appendix of the report. The computations of the surges during the time of flood have carried out in a successive manner. In comparing the long-term monsoon flood and the flood in the dam breaching disastrous event, the later case was critical. Therefore, the calculation is presented for the most adverse case of the dam breaching event. The basic parameter in the calculation is the flood hydrograph for adverse event and its resulting surge height and traveling distance in successive time period.

The flood is assumed to reach at certain interval of time and each interval a surge of certain height is attained which will travel downstream at a speed computed by the formulae shown in the following paragraphs. Hence, accumulating fronts of the incremental surges forms the resulting surge configuration.

The following are the main principle in the analysis of the flood hydraulics:

- Small increment of the time is considered.
- The calculation is carried by considering the unit discharge which is per unit width of the channel section.
- The initial depth of the flood is considered by calculating the depth of the channel in a given bed slope, bed material and the assumed flood in the section.
- It is considered that the flood behaves rapidly varied unsteady flow in the event of the dam breaching case, then the wave celerity is:

$$c = \sqrt{\frac{gy_2}{2y_1}(y_1 + y_2)}$$

- In the calculation the absolute wave velocity has expressed as:

$$V_w = \frac{v_1 y_1 - v_2 y_2}{y_1 - y_2}$$

- The incremental height of the surge is computed as:

$$h = \frac{c}{g}(v_2 - v_1)$$

- The scour depth for the flood event in the channel section is calculated as:

$$d = 0.473\left(\frac{Q}{f}\right)^{\frac{1}{3}}$$

$$f = 1.76\sqrt{m}$$

where scour depth, d is in m,

discharge Q is in m3/sec and

m is the particle size dia. in mm

After obtaining the flood height and calculating the scour depth for the flood event the protection work for the downstream land was established. Based on these calculations the desire dike structure for the flood protection work was carried out in the downstream area of the hydropower project.

5. Conclusions and Recommendations

Since the dam breaching case has varying discharge in space and time the calculation is considered as unsteady flow for the design of the protection work. In order to obtain the precise height of the surge, the incremental height of the surge is taken in the channel section. The calculation was carried out by considering a rectangular section due to the wide section of the river channel.

The maximum flood event should be considered for the durable protection work while carrying out the design. The most feasible structure and the locally available material should be utilized for the protection work.

Appendix

Design and Calculation Procedures

The following steps are considered for the design and analysis of the surge in the river reach.

- Col.1 Time in sec since the discharge started. The interval of time is determined arbitrarily. For accurate determination, a small interval should be used.
- Col.2 The unit discharge in m3/sec per m of channel width, equal to the total discharge shown by the hydrograph at corresponding interval divided by 200m.
- Col.3 Initial velocity of flow in m per sec before the incremental surge arrives, equal to V_2 (col.4) of the previous step.
- Col.4 Final velocity of flow in m per sec after the incremental surge passes, equal to the discharge value in col.2 divided by the normal depth Y_2 (col.7) of the previous step. This is an approximation, because Y_2 of the incremental surge under consideration is unknown as yet.
- Col.5 Initial depth in m equal to the final depth Y_2 of the previous step.
- Col.6 Height of the incremental surge in m, computed by

$$h = \frac{c}{g}(v_2 - v_1)$$

As an approximation, the value of celerity (c) in col.8 of the previous step is used in the above equation.

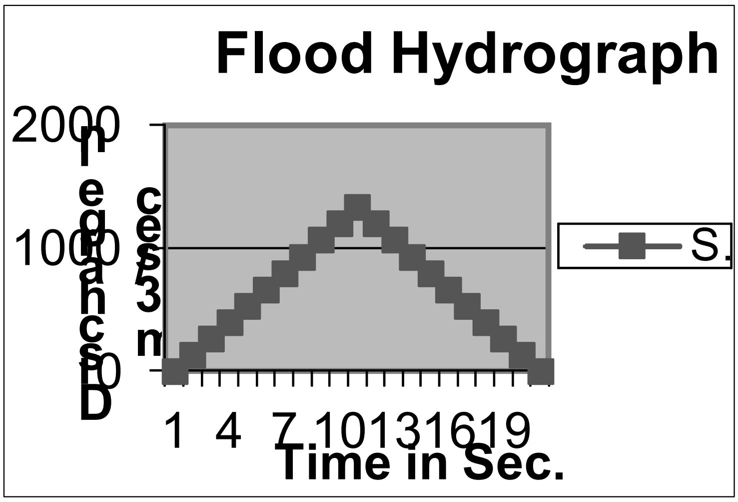
- Col.7. Final depth of flow in m, equal to the initial depth in col.5 plus the height of the incremental surge in col.6
- Col.8. Celerity in m per sec, computed by

$$c = \sqrt{\frac{gy_2}{2y_1}(y_1 + y_2)}$$

- Col.9.The absolute wave velocity of surge in m per sec, computed by

$$V_w = \frac{v_1 y_1 - v_2 y_2}{y_1 - y_2}$$

- Col.10. Cumulative value of the incremental surge is obtained from col.6.
- Col.11 Travel time in sec. until the discharge becomes the normal discharge, equal to the equalization time (600sec) minus the time in col.1 since the discharge started.
- Col. 12. Travel distance in m for each incremental surge until the discharge becomes normal, equal to the product of the time in col.11 and the absolute velocity in col.9



Surge in open Channel

1	2	3	4	5	6	7	8	9	10	11	12
T	**q**	**V1**	**V2**	**y1**	**h**	**y2**	**c**	**Vw**	**Sumh**	**t**	**L**
0	0	0.00	0.00	3.00	0	3.00	5.42	5.42	0.00	600	3254.40
30	0.665	0.00	0.22	3.00	0.12	3.12	5.59	5.65	0.12	570	3219.10
60	1.335	0.22	0.43	3.12	0.12	3.24	5.69	5.91	0.24	540	3189.51
90	2	0.43	0.62	3.24	0.11	3.35	5.78	6.20	0.23	510	3163.40
120	2.665	0.62	0.80	3.35	0.11	3.45	5.87	6.48	0.22	480	3110.44
150	3.335	0.80	0.97	3.45	0.10	3.56	5.95	6.74	0.21	450	3033.89
180	4	0.97	1.12	3.56	0.10	3.65	6.03	6.99	0.20	420	2935.17
210	4.665	1.12	1.28	3.65	0.09	3.75	6.10	7.22	0.19	390	2817.03
240	5.335	1.28	1.42	3.75	0.09	3.84	6.17	7.45	0.18	360	2681.32
270	6	1.42	1.56	3.84	0.09	3.93	6.24	7.66	0.18	330	2528.56
300	6.665	1.56	1.70	3.93	0.09	4.01	6.31	7.87	0.17	300	2360.53
330	6	1.70	1.50	4.01	-0.13	3.88	6.12	7.73	-0.04	270	2088.43
360	5.335	1.50	1.37	3.88	-0.08	3.81	6.08	7.60	-0.21	240	1822.98
390	4.665	1.37	1.23	3.81	-0.09	3.71	6.00	7.37	-0.17	210	1546.86
420	4	1.23	1.08	3.71	-0.09	3.62	5.92	7.15	-0.18	180	1286.97
450	3.335	1.08	0.92	3.62	-0.09	3.53	5.84	6.92	-0.19	150	1037.83
480	2.665	0.92	0.76	3.53	-0.10	3.43	5.76	6.68	-0.19	120	801.28
510	2	0.76	0.58	3.43	-0.10	3.33	5.67	6.42	-0.20	90	578.2104
540	1.335	0.58	0.40	3.33	-0.11	3.22	5.58	6.16	-0.21	60	369.4831
570	0.665	0.40	0.21	3.22	-0.11	3.11	5.48	5.87	-0.22	30	176.2385
600	0	0.21	0.00	3.11	-0.12	3.00	5.37	5.57	-0.23	0	0

12MW Jhimruk Hydropower Project

Downstream end showing photograph of 12MW Jhimruk Hydropower Project