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Study of Two Dimensional Dam Break Analysis Using HEC-RAS for Vir Dam

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ABSTRACT *– Dams are beneficial for society but flood occurs due failure of dam is dangerous for lives, properties and Environment. Prediction of dam break flows is necessary for forecasting and evaluation of flooding disaster and preparation of an emergency action plan. In this study dam break flood routing simulation is carried out by using HEC-RAS two dimensional model for Vir dam to determine Flood Susceptible area at the downstream side of dam. Result will helpful to Local Authority for appropriate planning and development.*

KEYWORDS- Flood, Flood routing, Flood mapping, Dam Break, HEC-RAS 2D model.

I. INTRODUCTION

Dam is barrier constructed across the river to store the water. This stored water is useful for Domestic, Irrigation, Industrial, hydro electricity generation etc. Floods occur due to dam failure always dangerous for so it is necessary to analyze flood wave propagation at the downstream side of dam for evaluation of flooding disaster. Dam Break Analysis is useful to identify the inundation area, flood depth, flood velocity and travel time of flood waves.

Dam break analysis is carried out for following reasons-

- Preparedness to tackle the disaster
- Preparation of inundation map
- Preparation of evacuation plans
- Evaluation of the risk at downstream of dam failure
- Emergency plans for reinstatement of infrastructure
- Design of protection measures.

II. LITERATURE REVIEW

Among all the reported natural disasters worldwide, floods accounted for about forty per cent and caused about half of all deaths. Asia faced the greatest threat of floods. Annually, more than 400 million people have been directly exposed to floods worldwide for the past two decades. A review of the data on disasters in India shows that droughts and floods have been two kinds of disasters that have affected the most number of people in India.

Dam-break flows can be studied by analytical, numerical and experimental methods. In practice, few raw data on dam-break flows are available due to the unpredictability of disasters. Dam Break study was started in 1850s in France. From 1850 to1950 there were no computers so the dam break study was focused on finding theoretical solutions and physical model test. From 1950 to1990 study was focused on study of factors responsible for dam break and flooding disaster at downstream of dam. From the period of 1990 to till study is focused on dam safety analysis. [1]

Most widely used tools for Dam break study are the National Weather Service (NWS) Dam-Break Flood Forecasting Model (DAMBRK); the U.S. Army Corps of Engineers Hydrologic Engineering Center Flood

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Hydrograph Package, HEC-1 (Hydrologic Center, 1981); and the NWS Simplified Dam-Break Flood Forecasting Model, SMPDBK (Wetmore and Fread, 1983). Of these models, DAMBRK was the most widely used. The National Weather Service released FLDWAV (Fread, 1993), the successor to DAMBRK. Mike11 and HEC-RAS are also useful tools for this exercise. [2]

Table 1. Details of natural disasters reported in India from 1900-2010

Type of disaster	No. of Events	Deaths	Total Affected(million)	Damage (000 US$)
Flood	237	60320	799.37	34145188
Storms (including tropical cyclones)	155	164221	93.29	11051900
Earthquake	26	61788	27.84	4079900
Drought	14	4250320	1061.84	2441122
Tsunami	1	16389	0.65	1022800
Extreme temperature (Heat wave/cold wave)	48	13881	0.0003	544000
Landslide and Avalanche	43	4807	3.84	54500
Epidemic	68	4543874	0.42	N.A.

Source: Compiled from the EM-DAT, CRED International Database (April 12, 2012)

From literature study, in India dam Break failure was occurred at three places. In 1917 at Gwalior, India Tigra dam failed due to water infiltrating through foundation. In 1961 at Pune, India Panshet dam was burst due to pressure of accumulated rain water. In 1979 at Morbi Gujarat, Machchu Dam-2 was failed heavy rain and flooding beyond Spillway capacity. [3]

III. METHDOLOGY

US Crops Army's Hydrologic Engineering center's River Analysis System (HEC-RAS) simulation model is used for dam break analysis study of Vir dam in Pune district, Maharashtra, India. HEC-RAS two dimensional model is powerful yet to easy to use software for determining water depth, discharge, inundation area, and flood wave velocity & water surface profile in two dimensions.

Analyzing of failure of dam is two steps process. 1) Analysis of actual breach of dam. 2) The outflow from the breached dam to be routed through the downstream valley to determine the resulting flood at population centers. From literature review we can state that majority cases of earthen Dam failure are due to Overtopping.

3.1 OVERTOPPING FAILURE

In overtopping failure water flows over the crest of dam. Head cut erosion starts from the downstream side of dam embankment. When cut reaches to upstream of dam mass failure will occur. [4]

3.2. BREACH PARAMETERS

Breach parameters include breach width, breach depth, side sloping angles & breach time. In this study dam break analysis is carried out for worst condition to determine flooding area at downstream side of dam so

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breach parameters are taken to get maximum breaching of dam and peaked out flow from breached dam is taken considering full reservoir discharge. [5]

3.3 DATA COLLECTION

Vir dam is constructed across Nira River at Purandar in Pune district.

1) Toposheet from Survey of India Pune

Toposheet Nos. - 47 O/1, 47 O/6, 47N/4

2) Digital Elevated Model (DEM) from Indian Geo-platform of ISRO, Bhuvan (www.nrsc.gov.in) with 30m resolution and WGS 84 datum and UTM projection.
3) Land use / Land cover classified satellite map of Study area from National Remote Sensing Center (www.nrsc.gov.in)
4) Discharge data of Vir dam from Irrigation department of Pune.
5) Geometrical data of Nira River –Vir dam from sub-divisional office, Wathar colony Purandar.

Table 2. Dam details

Name of Dam	Vir Dam
River	Nira
Nearest City	Purandar, Pune
Basin Name	Krishna
Dam Type	Earthen / Gravity
Dam height	35.81m
Top of Dam (RL)	583.51m
Dam length	4008.0m
Top width of Dam	7.70m
No. of Gates	09
Gate type	Radial gate
Gate size	12.50x8.23m
Weir Shape	Ogee
Spillway Type	Concrete

HEC-RAS 5.0.1 (2D) Model is used to create simulation for analyzing flood susceptible area at downstream side of dam. Two-Dimensional Unsteady flow analysis is carried out for Dam break analysis and to determine the resulting flood at downstream side of Dam. Unsteady Flow Analysis method used with Implicit Finite Volume algorithm and Wave Diffusion equations. [6]

3.4 DAM BREAK ANALYSIS FOR VIR DAM

Digital Elevation model (DEM) from Indian Geo-platform of ISRO, Bhuvan (www.nrsc.gov.in) with 30m resolution and WGS 84 datum and UTM projection is used. Land use / Land cover classified satellite map of LISS-III sensor, 30 m resolution resource sat II satellite data, from National Remote Sensing Center (www.nrsc.gov.in) is used.

From DEM Terrain Model was created.

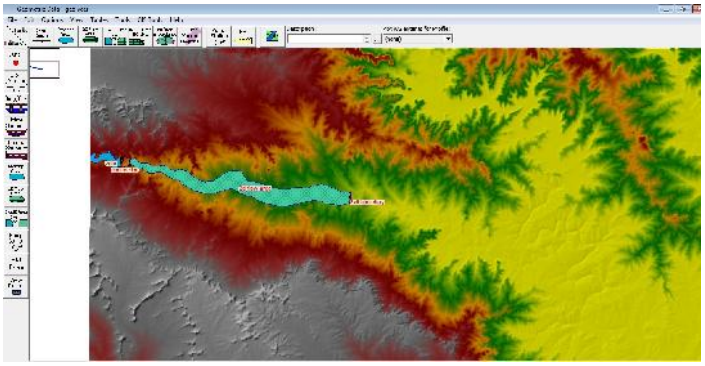

Fig. No.-1. Geometric data of Vir dam

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After creation of Terrain model, 2D flow area boundary and Storage area boundary were marked and then mesh formation was done.

Boundary conditions - 1) Storage area -2d Flow area connection

2) Exit boundary- Normal Depth

3) Lateral Flow

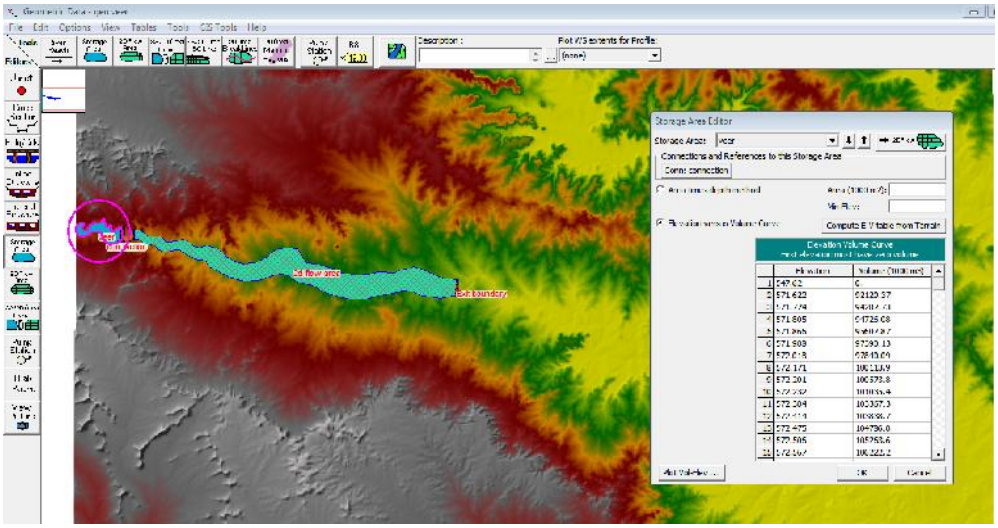

Fig. No- 2.Elevation Volume curve –Vir dam

Table 3. Storage Capacity of Vir Dam

Elevation (M)	Volume (1000 M3)	Elevation (M)	Volume (1000 m3)	Elevation (M)	Volume (1000 m3)	Elevation (M)	Volume (1000 m3)	Elevation (M)	Volume (1000 m3)
571.622	92120.37	572.902	111615.4	573.908	129073.6	575.005	150450.8	576.072	173721
571.774	94287.73	572.933	112116	573.969	130195.5	575.102	152300.8	576.103	174423.3
571.805	94726.08	573.024	113628.4	573.999	130759.3	575.188	154262	576.255	177967.1
571.866	95607.87	573.237	117219	574.03	131325.3	575.371	158146.2	576.35	178000.5
571.988	97390.13	573.268	117738.9	574.213	134760.2	575.401	158800.6	576.407	181563.7
572.018	97840.09	573.298	118260.8	574.64	143044.5	575.615	163439.2	576.499	183747.5
572.171	100113.9	573.329	118784.4	574.67	143650.8	575.645	164110	576.529	184479.7
572.201	100573.8	573.481	121428.6	574.7	144259	575.889	169551.9	576.682	188170.3
572.232	101035.4	573.512	121962.9	574.731	144869.3	575.92	170241.5	576.712	188918.4
572.384	103367.3	573.695	125206.6	574.81	146000.2	576.011	172323	576.834	191921.4
572.414	103838.7	573.725	125753.4	574.883	147950.1	576.03	172400	576.956	194962.6
572.475	104786.8	573.877	128515.4	574.975	149822.7	576.042	173021	576.97	195000.5

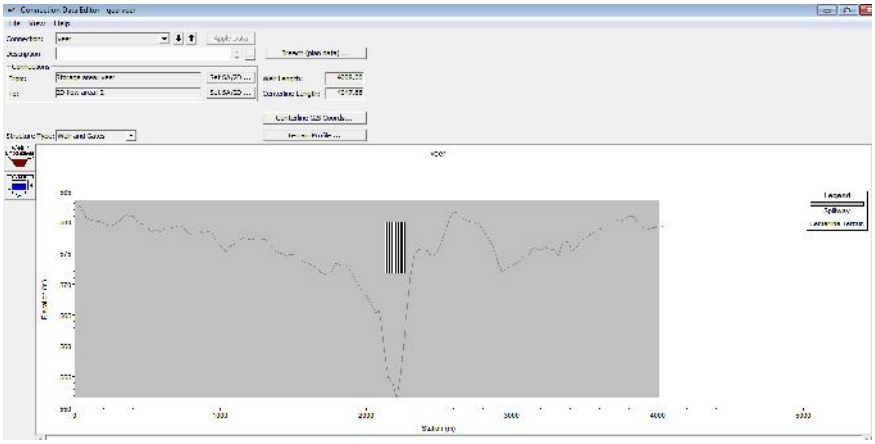

Fig. No-3. Vir Dam- Weir & Gates details

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3.6 BREACH PARAMETERS

Breach Width- 800m

Breach bottom Elevation-570m

Left side slope-1:50

Right side slope-1:70

Breach time- 6 minutes.

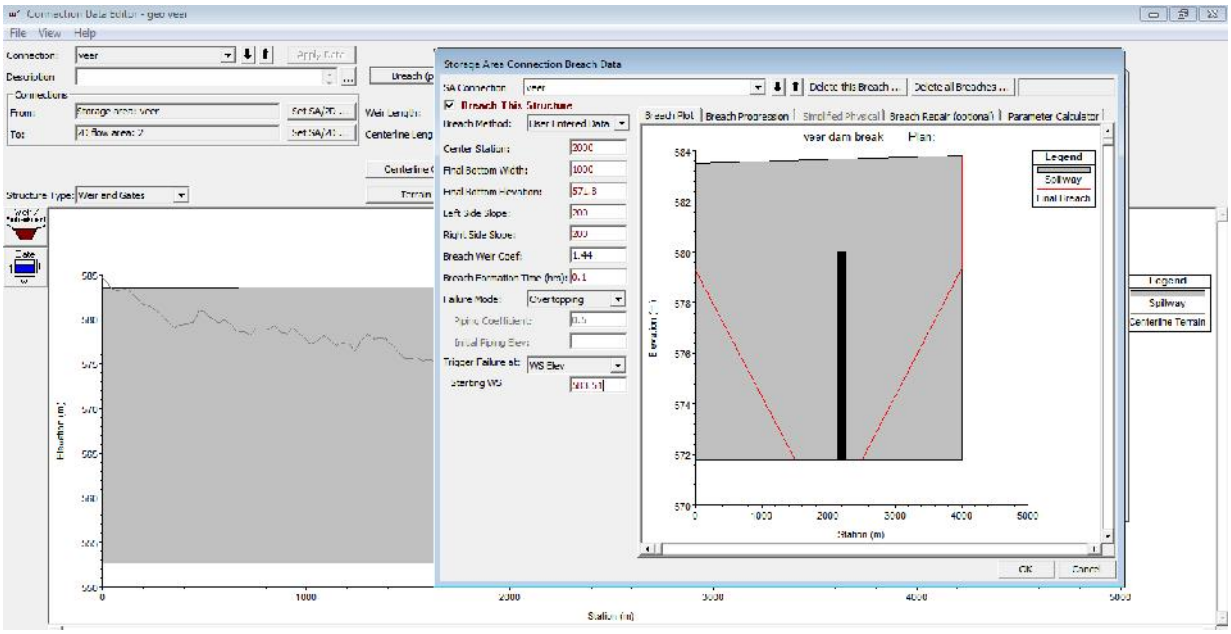

Fig: 4. Breach details- Vir Dam

IV. RESULT

Unsteady flow simulation is carried out for dam breach study. Hydrograph output interval taken as one hour, computational interval taken 15 sec. Vir dam failed at lateral flow discharge 7000m^3/sec. Following area is under flooding.

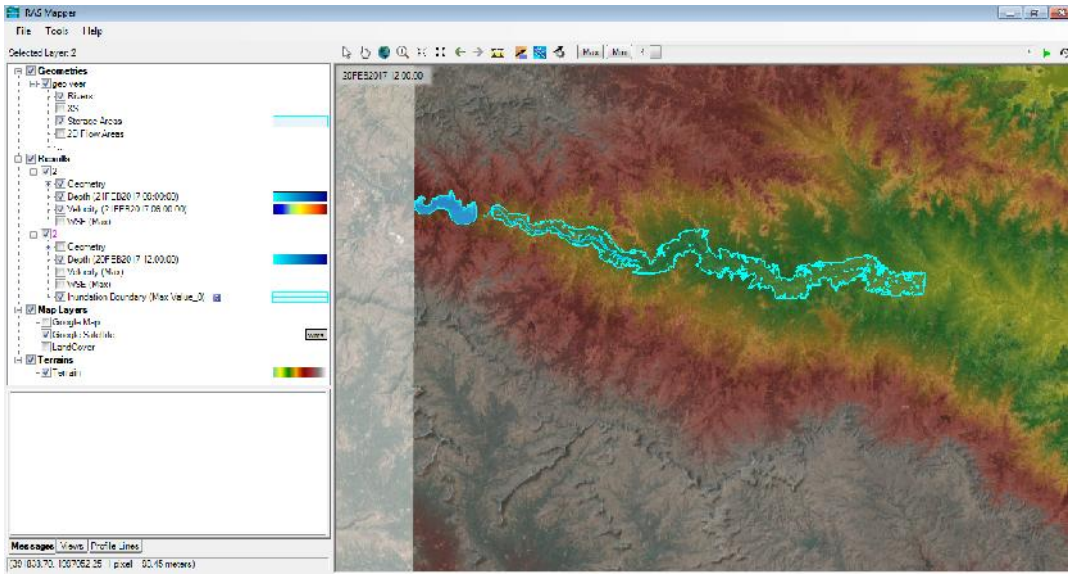

Fig. No- 5 Inundation map

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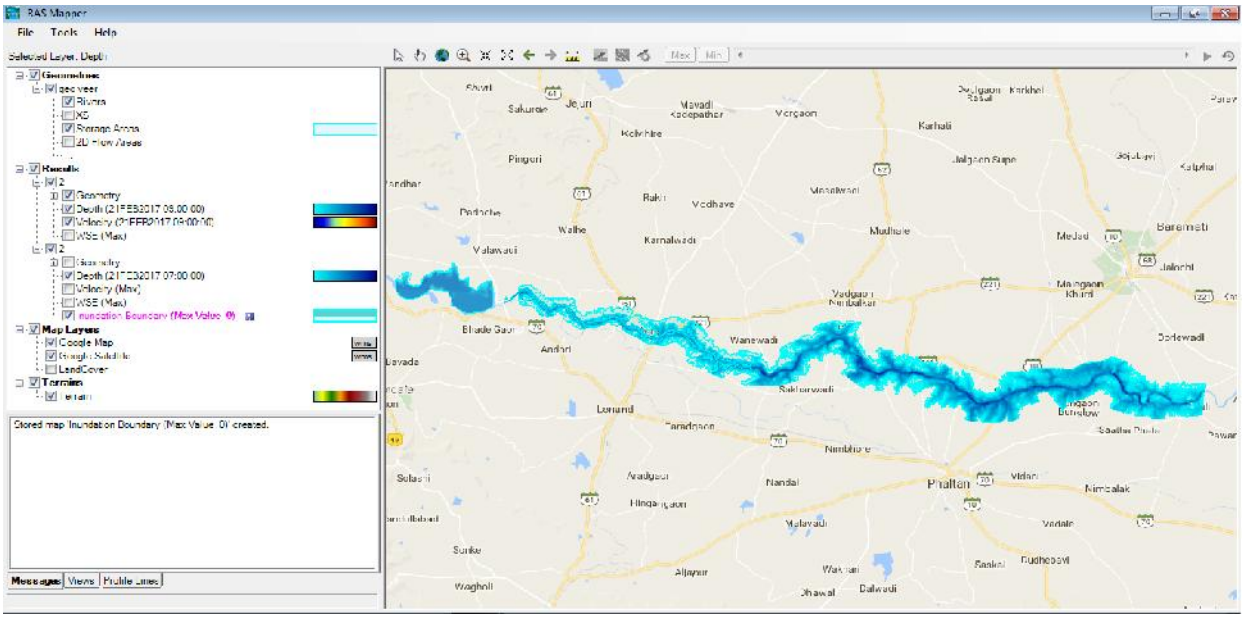

Fig. No- 6 Inundation map

Ward No. 1, 2, 3, Jubilant Colony, Nira-Andori raod, Nimbut area, Malashi-Nimbut Road, Mirewadi, Hol, Murum area, Khunte area, Sangavi area are under flooding.

V. CONCLUSION

Traditionally, flood defense planning has focused on safety standards, such as dike design levels or reservoir volumes required to ensure pre-defined protection levels for the population and the economy. Protection of the community against floods this approach neglects the amount of valuables protected by a defense system and, hence, disregards the efficiency of flood protection measures. [7]

Adverse effects of floods can be minimized by proper planning and future development if the occurrence of floods and magnitude of flood can be predicted and managed systematically. So this study will helpful to local planning authority for taking appropriate decision.

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