Dikes and Levees – Classification, Formation, Morphology, Failure and Rehabilitation

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Abstract: This study focused on the classification, formation and morphology of dikes and levees. Several case studies have been reviewed to observe the commonality between different levees in different parts of the world. Studies on the failure and rehabilitation of levees have been discussed.

1.Introduction

Dikes or Levees, generally formed naturally or constructed of impervious clays and built of sandy soil, are structures used to protect the land from floods or tides (Ojha, et al. 2008). Turbidity current is sediment laden fast moving water flowing down slope. These currents transport large volume of sediments through continental slope which plays an important part in the construction of one of the best-studied sedimentary objects called levees which are often found to be located on the sides of the channel (Gervais et al. 2001).

2.Objective:

The main objective of this study was to review the classification, formation, general morphology of dikes and levees and analyze a few case studies on the failure and methods of rehabilitation.

3. Formation, Classification and Morphology

The words, Dike and Levee though can be used interchangeably, have one major difference. A dike is a barrier that is used to protect the land from water, if not the land will be all the time under water. A levee is a flood control device used to protect the land from the flood water which other-wise will be below ground level (Fig. 1a). Major classification of the levee comes from the origin of the way that they have been formed or constructed, namely, artificial and natural levees.

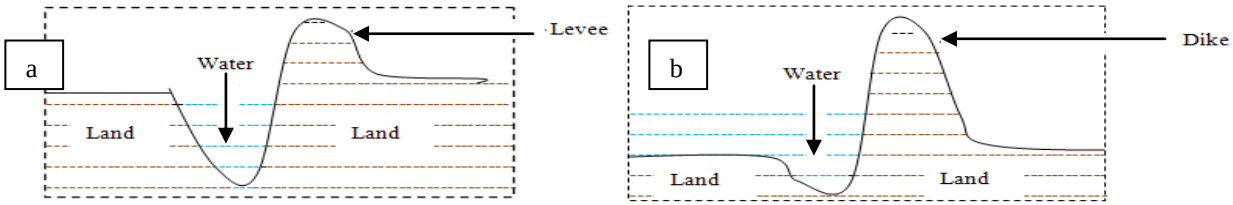

Figure 1: Schematic Representation of a) Levee and b) Dike

The artificial levees can be found mainly along the sea, where the dunes are not strong enough, along the rivers, for protection against high floods and along lakes. Dike is a type of sheet intrusion that intervenes massive rock formations and planar wall rock structures. This explains the fact that the natural dikes can be classified either to be of sedimentary or igneous in origin. An intrusive dike is an igneous body with its thickness usually smaller than the other two dimensions. Some of the studies that were conducted to determine the morphology and formation of levees and dikes, are summarized in Table 1.

Table 1: Morphology and Formation of Levees and Dikes

Study	Type of Study	Morphology - parameters	Grain Size	Remarks
Gervais et al (2000)	Site investigation – Zaire deep fan	Levee thickness – 15 cm thick	10 - 50 microns	The thickness of the levee formation was categorized into three facies.
Cazanacli et al (2000)	Site investigation – Lower Saskatchewan	Slope - 0.001 – 0.024 Levee width – 27		Slope of 0.01 was used to define the boundary of the levee. Vegetation was observed to identify the approximate

	River.	– 260 m Levee height 0.62 – 1.69 m		width of the levee.
Adams et al (2004)	Site Investigation - Anastomosed channel flood plain complexes	Levee Slope - 0.002 to 0.077 Levee Width - 7.6 m to 945.1 m Levee Height - 0.4 m to 3.2 m	7 – 130 microns	Levee slope - defined as the line of best fit to the flood plain surface in the region adjacent to the channel and channel ward of the first significant change in slope. Levee area - which is approximated by the right triangle whose hypotenuse is the levee slope.

The sediments collected by the speed of water in the river or sea, reaches the banks or the shore and on their accumulated deposition, natural sedimentary levees are formed.

4.Failures and Rehabilitation

Failure in Levee, also called levee breach, brings the water stored on one side of the levee to the side where land is. The three main causes for levee breach is the erosion owing to water seepage through or under the levee, foundation failure of the levee and overtopping of water owing to the insufficient height of the levee. Table 2 summarizes few common disasters which lead to levee breach.

Table 2: Famous Levee and Dike Breaches in the Past

Date and place of Occurrence	Cause for Occurrence	Type of Failure	consequence	Remarks
18-19 Nov 1421, Netherlands	St.Elizabeth's flood	Overtopping	100 sq mi land in Netherlands submerged. 2K – 10K people died.	Cause was the surge of water in North Sea flooded the rivers causing the overtopping of dikes. Areas flooded were Zeeland and Holland.
1 Nov, 1570 – Dutch Coast	All Saints Flood – Long period of storm.	Overtopping	Over 20000 people died	In Zeeland, small islands Wulpen, Koezand, Cadzand and Stuizand were permanently lost.
1 Jan, 1927, Cumberland river	Flood - heavy rains since summer 1926 leading to accum. water flow in river Mississippi	Overtopping – 56.2 ft	Flooded 27000 sq mi. 246 people died. 400 million damage.	Many southern states were affected. Few levees in Louisiana were intentionally breached to redirect the flood water and prevent flooding in New Orleans.
29 Aug, 2005, New Orleans	Hurricane Katrina	Overtopping – 10 ft; Foundation Failures; Erosion	Over 100000 homes flooded.	Height of one levee was 14 ft and the surge height was 24 ft. this resulted in overtopping.

Adam et al (2010) proposed innovative methods of compaction to rehabilitate flood protection dikes such as compaction using rollers with polygonal drum and rapid impact compactor. Which increased the thickness of the compacted soil layer, permanent kneading effect and ensured good interlocking with the superimposed soil layer and also soil volume reduced and hence the void ratio, permeability increased and bearing capacity increased and stability and reduction of erosion risk was obtained.

5.Conclusion

In this study, the formation, morphology, classification, failures and rehabilitation of levees were discussed. Levee, being an earthen structure is to be constructed impervious and according to the design conditions by predicting the expected height of the surge as most of the levees fail due to overtopping.

6.References

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