Classification of the Eroded Cavings behind Concrete-faced Embankments by Ground-Penetrating Radar

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Outline

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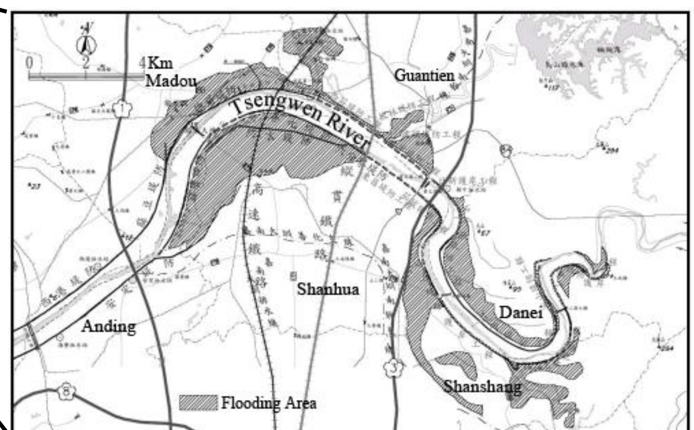
Introduction

- Concentrating rainfalls in plum rain and typhoon seasons often cause floods in Taiwan.
- The flood along Tsengwen River in southern Taiwan caused by Typhoon Nari in September, 2010.
- The flooding area was about 1,293 ha, and the total loss was about 8 million USD.



Introduction

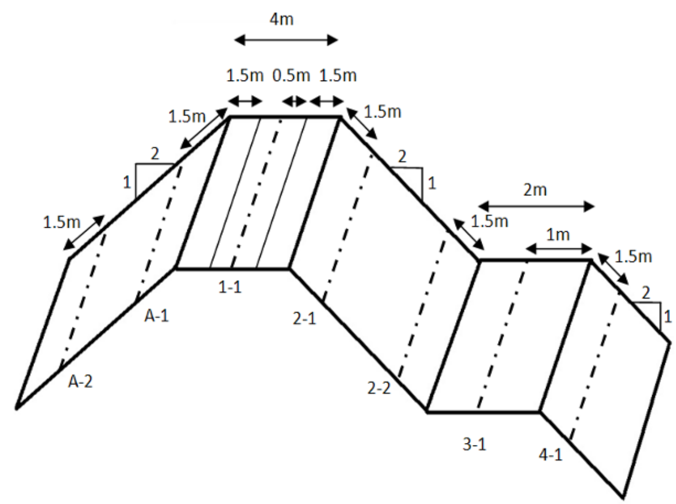
- The mechanism of the erosion at the river embankments are:

  (1) The river water scours out the earth fill at the bottom of dike and generates cavities behind the concrete plates.

  (2) Rainwater infiltrates to the joints and cracks on concrete plates and erodes the earth fill behind.
- The river water scourring can be determined by the scouring effect at the toe of the river dike.
- Erosions caused by the rainfall infiltration is difficult to be detected visually because the concrete plate is thick and rigid.
- In the early stages of erosions, insignificant signs of damage can be observed on the concrete plates.

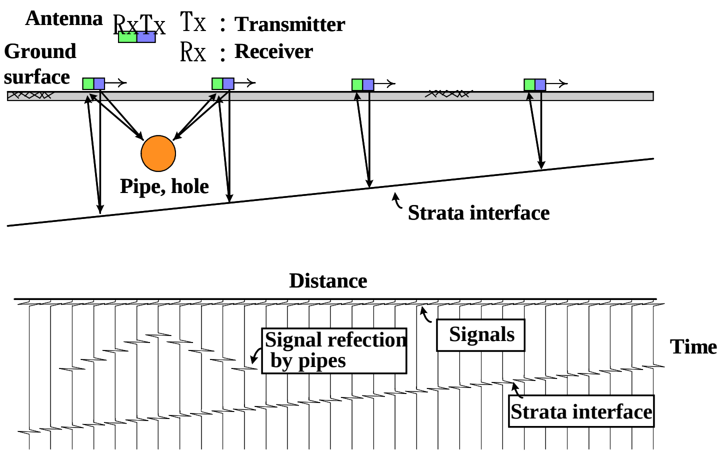
*Non-destructive testing method? GPR?

Investigated river dikes



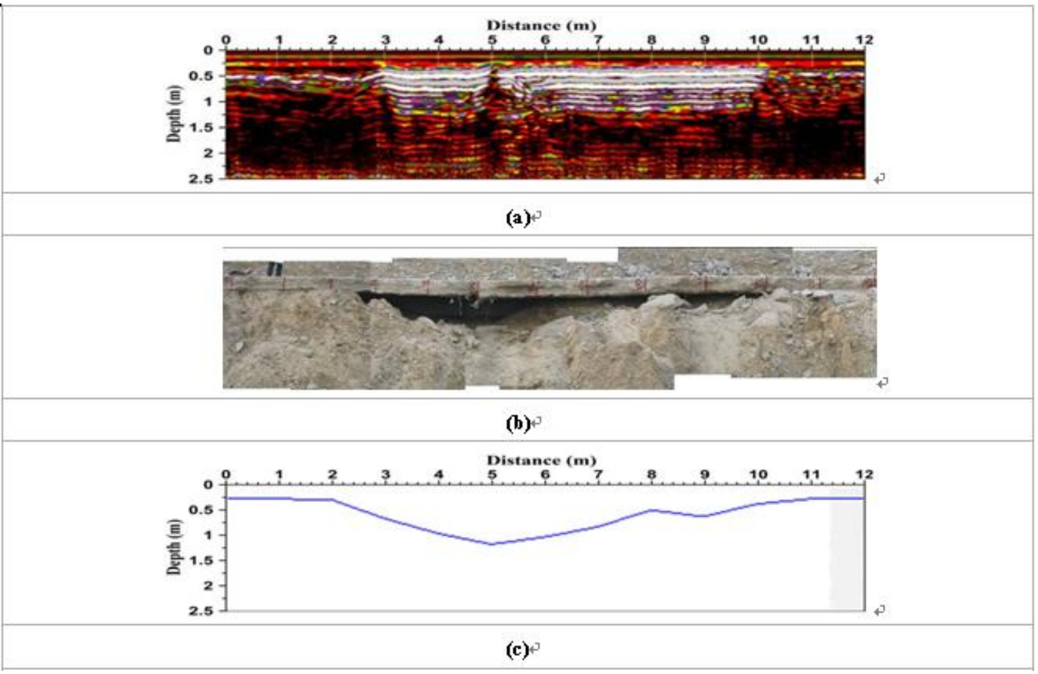
- Shan-shang embankment was built between 1998 and 2011.
- This section is close to the river trench (about 40-70 m) and often scoured out by the stream.
- The land side slope has 1 step concrete-faced, and the river side slope has 2 steps .

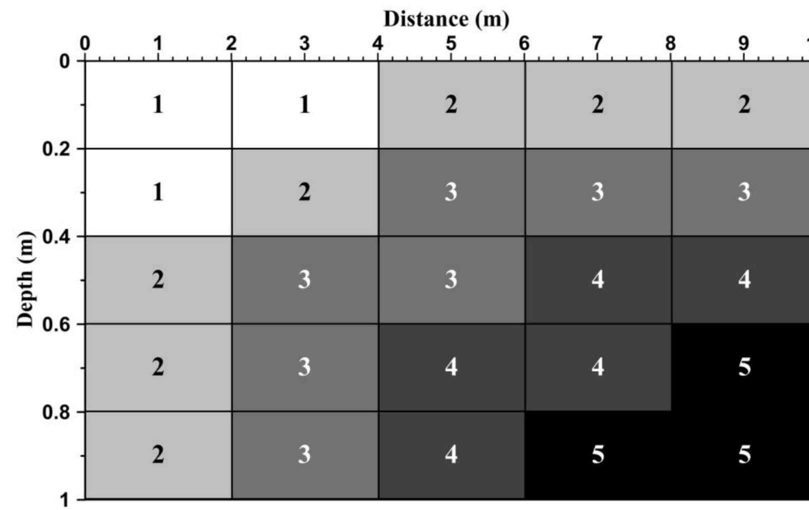
Research method



- A 400MHz antenna is used in this study.
- The wave velocity of the concrete and soils is assumed to be 0.1 m/ns.
- The maximum two-way travel time is set 50 ns in this study with the maximum signal penetration depth is 2.5m.

Research results





GPR detection at another dike

Research results

No. of concrete plate		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Survey line	1--1	1	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	2
	1--2	3	3	2	1	1	2	3	3	2	2	1	1	1	2	2	1	1	1	1	1	2	2
	2--1	2	3	3	3	4	4	2	1	1	1	2	1	2	2	1	1	1	1	1	1	1	1
	2--2	3	3	3	3	3	3	3	1	2	1	1	1	1	2	1	1	3	3	3	3	1	2
	3--1	1	3	3	3	3	3	3	2	1	2	2	3	1	2	1	1	1	1	1	1	4	3
	4--1	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	4	4	3	4	3	5	2

No. of concrete plate		23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Survey line	1--1	2	2	2	1	2	2	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2
	1--2	2	1	3	2	3	1	2	2	2	2	1	3	3	3	3	3	3	3	1	1	1
	2--1	1	2	3	3	3	3	2	2	2	1	3	3	4	3	3	3	2	2	2	1	2
	2--2	1	1	3	3	3	3	3	3	3	3	1	1	1	1	3	3	1	2	3	3	3
	3--1	3	4	1	2	2	1	1	2	1	1	1	2	4	1	3	1	2	1	1	1	1
	4--1	3	4	2	2	3	3	2	2	2	2	3	2	4	3	4	2	2	3	2	3	2

Research results

- The erosion degree of each span can be assemblied after classifying the erosion degree obtained from the survey lines at the crown, upper slope, mid platform, and lower slope.
- High erosion degree occurs at Spans 2 to 7 and Span 34 to 37.
- High erosion degree can be found at Line 4-1, showing that the toe of the embankments were eroded severely by the river.
- The engineers can identify the locations of high erosion degree from the figure and analyze the mechanism of embankment erosions.

Conclusions

- In this study, the erosion degree of concrete-faced dikes was investigated by the length and depth of the eroded cavities using GPR.
- The erosion degree of each span of the dikes was classified.
- Since the severely eroded areas can be discovered, we can decide the priority of maintenance to the river dikes after putting the erosion degree of each span together.
- The GPR images provide detail information for further study on the possible causes of dike erosion.

Thank you for your patient