

reservoir emptied, and the earth dam remained intact. This was at Lima, Montana, in May, 1894.

The 5th, 6th, 7th, 8th and 9th are again cases of earthen dams; but in these five instances, the first was due to an insufficient spillway. The second had a central wall of sheet-piling. The third and fourth core walls of stone masonry. The latter had a stone core and wall of puddled clay, the better to secure its impermeability.

All these earthen embankments which would have probably withstood either percolation or displacement forward, are said to have been destroyed by flow of freshet water over crest of dam.

Case No. 10, the Hassyan dam, Pennsylvania, of February, 1890, is that of a rock filled dam of a height of one hundred and ten feet, one hundred and forty feet broad at base, and only ten feet at top, the outer slope of which was lined with heavy blocks of granite, the inner slope also lined with heavy ashlar laid dry, and this again with a wooden revetement.

Such loose structured embankments might, sooner or later, have failed by percolation, except possibly through the wooden lining, so long as undisturbed, and if driven to an impermeable foundation; but, as it is, the above is said to have been destroyed by overflow, its twenty-six feet waste-weir being entirely inadequate.

In the foregoing cases, the damages done to adjoining or riparian property ranged from fifty thousand dollars to eight hundred thousand dollars, and the loss of human life from seven to one hundred and fifty.

The next case, or No. 11, is the ever memorable one of the Johnstown dam, across the south fork of the Conemaugh River, in May, 1889, where the persons drowned have been variously estimated at from four thousand to ten thousand, and the damages at nine million dollars.

This dam had been constructed in 1852 as a feeder for the Pennsylvania canal. It was of clayey earth, some seventy-five feet high, twenty feet wide at top, and with outer slope of one and a half to one, and inner ditto of two to one, with slight rip rap lining; its breadth of base being two hundred and seventy-two feet and a half. It contained five billion gallons of water, and hence the immense destruction and loss of life.

The grave mistake, says Mr. Hill, was made of having a depression in the crest of the dam towards the centre of its length, and