ICE Publishing

Badr and Venables
ISBN 978-0-7277-6525-3
https://doi.org/10.1680/oicwe.65253.263

INTRODUCTION TO CHAPTER 4 ON WATER STRUCTURES

A. Badr[1], A.A. Ganiyu[1] and R. Mangabhai[2]*

[1]Department of Civil Engineering, Military Technological College, Muscat, Oman
[2]The Institute of Concrete Technology, London, UK
**Corresponding author*

Natural water resources are limited, unevenly distributed, and subjected to seasonal fluctuations. Engineering infrastructure is vital to impounding and/or channelling water from natural sources towards demand areas for human use. Water structures, in general, and dams in particular, are essential for mitigating the impact of catastrophic disasters from floods and storm water. These amazing structures withstand tremendous loads and extreme weather conditions resulting from climate change.

There are six papers in this chapter addressing important aspects of water structures. The selected papers used data collected from a variety of sources including results of experimental programmes, field investigation and historical data from the region. These papers address issues related to stability of dam, mitigation of floods, sediment removal to increase reservoir capacity and coastal protection. The papers offer solutions to problems and recommendations for the development of guidance and standards.

The first paper deals with potential seismic activity in Oman which could result in disruption, damage to the surrounding area and socioeconomic impact. The stability of Dayqah Dam was evaluated, by Chowdhury and Badr, using a computational model built using the RS-DAM package, which can carry out a pseudo-dynamic rigid body analysis of dams. A wide range of parameters was studied and the results were discussed. It was shown that the most influential parameters controlling the sliding displacements were the spectral acceleration imposed onto the dam and friction coefficients at the dam-foundation interface. It was alarming that the factor of safety against sliding was observed to drop below 1.0 at a specific time in the duration of seismic loading. The findings underscore the need to incorporate seismic effects in the design of large water structures in Oman. The results from the study provide guidance on future research to predict the stability of dams.

Staying with the subject of behaviour of dams under extreme conditions, Al Lawati and Al Jahwari studied the buckling behaviour of thin shell concrete arch dams with geometrical nonlinearities. There are several standards available to design arch dams. A finite element model was developed for the arch dam using ABAQUS finite element package. Two different analyses were used for comparison, linear buckling analysis (LBA) and geometrically nonlinear analysis (GNA). Several interesting findings from the study are reported and it is thought that these could be used for consideration in developing new design codes.

The third paper addresses the issue that extreme weather conditions around the world have been experienced over the last decades and there has been flash floods in the Arabian Peninsula and North Africa, including Egypt. Flash flooding in Gonu 2007 event caused many fatalities and billions USD of economic losses in Oman only. Similarly, the 2014 flash flood in Egypt caused losses of 1 billion EGP in Taba city, alone. This study has been undertaken to investigate viable management solutions to reduce the effects of flash floods. Remote sensing data have been used along with a Hydro-BEAM model to predict and evaluate different mitigation scenarios of flash floods at the target basin. Digital Elevation Model (DEM) data and satellite imagery have been used to also propose suitable locations of dams based on available reservoirs' total volumes and delineated watersheds. Researchers from Kyoto University and Jam Dam Engineering Centre have carried out field investigations to understand the climate of Egypt and collaborate on pilot projects. Several case studies and methodology in collecting data were evaluated using Hydro-Beam model and Digital Elevation Model to provide solutions to mitigate flash flooding. The simulation results highlighted the main feature of wadi flash floods as its hydrographs have an extremely steep and rapidly rise to peak flow after only a few hours, which increase the degree of risk of flash floods compared to normal floods. The results will help in providing management of flash floods in Egypt and Arabian Peninsula.

Linking the first two papers on dams and the third paper on flash floods, the fourth paper discusses how sedimentation occurs in reservoirs. Water from rivers and storms has particles which deposits over time resulting in reduction of water storage capacity if not addressed properly. A case study on Mosul dam reservoir in Iraq has been carried out by Altaiee. A review of the existing sediment flushing process is discussed together with alternatives. Criteria were established on evaluation of the flush process and evaluated using SBR, LTCR, FWR and DDR. It is shown that SBR is more than 7, whilst LTCR gave a value higher than 0.8 and in both cases these values agree with successful flushing. It is concluded that Mosul reservoir can be flushed successfully, and further evaluations are required to monitor successful flushing and environmental impacts.

Continuing on the subject of storm water, the fifth paper deals with commonly used design software to establish a storm profile in Oman by Awadallah and Hamed. In arid and hyper arid regions, storms tend to be shorter, and their patterns are very different from those in humid regions. This study uses hyetographs from 48 rainfall gauges with 1354 storm events to establish storm profiles which have been analysed using Huff's and the Soil Conservation Service (SCS) approaches. The analysis of this large number of storms indicated that storms can be classified into six categories according to their durations. A methodology was developed to analyse the data according to various parameters and their results are presented. Recommendations from the research are outlined and further research is required to prepare guidance on commonly used design storm software.

The final paper in this interesting chapter is by Reeve and it is dealing with coastal protection with experimental investigation of bimodal wave overtopping of coastal seawalls. Wave overtopping rates are a key quantity in the design of coastal flood defences and breakwaters. A coastal laboratory wave tank at Swansea University has been used to generate waves with an HR Wallingford computer-controlled piston paddle. This powerful setting has the capability to reproduce user-defined spectra of different types. It is also equipped with an active wave absorption system to minimize the wave reflection from the wave board. The tests were conducted at three water depths and in each case a random sequence of 1000 waves were generated, and overtopping water collected and measured. However, the overtopping rate for bimodal waves spreads beyond the confidence interval predicted by established formulas. The study concluded that bimodal conditions may lead to greater overtopping than anticipated in current design guidance, therefore the protection level of structures that are designed according to current guidance may be reduced.

The findings of the papers included in this chapter offer valuable scientific and practical solutions to current issues in water structures. Some of them could have significant implications on improving the design of water structures, particularly dams. Others present viable management solutions. More importantly, some of these papers provide valuable recommendations for developing new design codes and guidelines for designers. In fact, each paper is an interesting read and provides a valuable source of information for students, researchers, engineers and decision makers.