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Structural Analysis of a Historical Dam

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Abstract

Studies pertaining to earthquakes began only around the 17th century and those related to their effects on structures began even later in the 19th century. Hence structures made during or prior to this period are often not designed for seismic forces. India has many historical structures that were constructed long before the codes for seismic resistant design came in practice and, in many regions the seismic activities too have changed over time. It is therefore necessary that these monuments are analysed for safety during seismic activity. This paper aims to analyse the probable failure patterns of a composite dam about 120 years old using time history analysis. 2D modelling and analysis has been carried out using ANSYS14.0 to estimate stresses in the dam for three time histories with varying PGA values. Stress results show that failure of weaker materials at joints may cause internal crack formation in the dam.

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*Keywords:*Composite dam; Time history analysis.

1. Introduction

The dam considered in the present case is a singular dam made up of un-coursed rubble masonry, lime surkhi concrete and reinforced concrete. Dams are checked for failure due to overturning and sliding, however a dam may also fail due to failure of its materials, i.e. the compressive stresses produced may exceed the allowable stresses, and the material may get crushed. Cracking may also occur in masonry and concrete gravity dams which are usually designed for zero tension, because these materials cannot withstand sustained tensile stresses. Loading conditions

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including gravity, hydrostatic, uplift, hydrodynamic forces and seismic loading have been taken to obtain the maximum stresses at various significant locations in the dam. Failure of dams is primarily analysed for overturning, sliding, tensile and compressive failure. In case of dams made up of multiple materials, there is a possibility of internal failure due to failure in the weaker material. In such a case, no external signs of damage may be visible. The aim of this paper is to identify the possibility of occurrence of such a failure. The dam considered here is made up of three materials and has been described subsequently. Aging may also lead to deterioration of material strength. This study involves linear analysis for static and dynamic (seismic) load cases. The failure zones and patterns have been identified for three time histories with different PGA values.

2. Characteristics of Dam

2.1 General

A 120 year old dam has been considered for analysis. It is a gravity dam having a back and front facing of uncoursed rubble masonry in lime surkhi mortar, a core of lime surkhi concrete and an additional reinforced concrete backing added for strengthening at a later stage. Fig. 1 shows the cross section of the dam [1]. Basic features of the dam are as listed in Table 1.

Table 1.Basic features of dam

Type of dam	Gravity
Age	120 yrs.
Height	52.66m
Length	365.85m
Crest width	2.6m
Base width	42.2m
Maximum Water Depth	42.291m
Materials	Rubble masonry in lime surkhi mortar facing, lime surkhi concrete core, Reinforced concrete backing added later for strengthening.

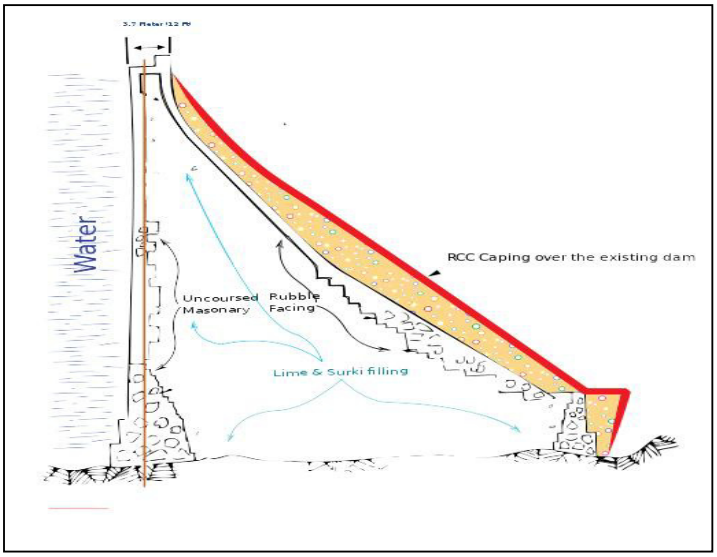

Fig. 1. Cross section of dam