

Concrete Face Rockfill Dams— Design, Construction, and Performance

Proceedings of a Symposium sponsored by the
Geotechnical Engineering Division of the American
Society of Civil Engineers in conjunction with
the ASCE Convention in Detroit, Michigan

October 21, 1985

Edited by J. Barry Cooke and James L. Sherard



Published by the
American Society of Civil Engineers
345 East 47th Street
New York, New York 10017-2398

The Society is not responsible for any statements
made or opinions expressed in its publications.

Copyright © 1985 by the American Society of Civil Engineers.

All Rights Reserved.

Library of Congress Catalog Card No. 85-72723

ISBN 0-87262-503-6

Manufactured in the United States of America.

PREFACE

This October 1985 Symposium on the Concrete Face Rockfill Dam (CFRD) follows the Symposium on Rockfill Dams held at the Portland, Oregon June 1958 ASCE Convention. The 1958 Symposium was published in ASCE Transactions, Vol. 125, Part II, 1962, and included discussions and closure discussions in an exclusive volume. Most of the world's high rockfill dams of all types were presented in that Symposium.

The 37 papers in this October 1985 Symposium are for the CFRD only. This type of dam is being used with greater frequency and to greater heights in the last decade and at present.

The developments leading to the progress are many, and are presented in the papers in this Symposium. Major features contributing to progress are the use and development of the smooth drum vibratory roller and design improvements in the cut-off to the foundation and concrete face slab and joints. Papers on the performance of the existing modern dams, special papers on rockfill zoning, dam construction and seismic analyses, and on dams currently under design are included.

The symposium was proposed to the GT Executive Committee by Richard L. Volpe, Chairman of the Embankment Dams and Slopes Committee. J. Barry Cooke and James L. Sherard were appointed as the Symposium Committee Chairman and Co-Chairman. Papers were invited and the favorable response is evident in this volume. Members of "The Symposium Committee" are the reviewers who submitted prompt and thorough reviews.

It is the current practice of the Geotechnical Engineering Division that each paper published in a special technical publication (STP) be reviewed for its content and quality. These special technical publications are intended to reinforce the programs presented at convention sessions or specialty conferences and to contain papers that are timely and may be controversial to some extent. Because of the need to have the STP available at the convention, time available for review is generally not as long and reviews may not be as comprehensive as those given to papers submitted to the Journal of the Division. These STP reviews ordinarily are carried out within a three month time frame. Therefore, it should be recognized that there is a difference in the purpose and technical status of contributions to the special technical publications as compared to those in the Journal. Reviews of papers published in this volume were conducted by the Embankment Dams and Slopes Committee of the Geotechnical Engineering Division. The following committee members or cooperating persons from the general membership reviewed these papers:

Shalom Blaj
Donald H. Babbitt
Hugh M. Brown
Richard E. Burnett
Gilles J. Bureau
J. Barry Cooke
Johnnie V. Holm

Don R. Hooper
David E. Kleiner
G. Robert Koch
Richard L. Kulesza
Thomas M. Leps
Andrew H. Merritt
Michael J. Morris

Ralph B. Peck
Nelson L. de S. Pinto
Warren H. Schumann
James L. Sherard
Arthur G. Strassburger

William F. Swiger
Gerald R. Thiers
Mircea S. Vasilescu
Richard L. Volpe
Thurman R. Wathen

The papers contained in these proceedings are eligible for discussions in the *Geotechnical Journal* and are eligible for ASCE awards. Discussions are invited and encouraged. They should be made to the book, "The Concrete Face Rockfill Dam", followed by the title of paper and name of author. The closing date for submission of discussions is February 1, 1986. Discussions, including closures, will be published in a future volume of the *GT Journal*.

J. Barry Cooke, F. ASCE
James L. Sherard, F. ASCE

Editors

CONTENTS

EXISTING DAMS

Performance of Cogoti Dam Under Seismic Loading Luis Arrau, Ismael Ibarra, and Guillermo Noguera	1
New Exchequer Dam, California Thomas M. Leps, C. A. Cashatt, and R. N. Janopaul	15
Design, Construction & Performance of Fades Dam J. C. Millet, F. Louis, and F. Robert	27
Weak Rock in Two Rockfill Dams R. J. Good, D. L. W. Bain, and A. M. Parsons	40
Alto Anchicaya Dam—Ten Years Performance Bayardo Materon	73
Membrane Sealing of Rouchain Dam M. Salembier	88
Golillas Dam—Design, Construction and Performance Fabio Amaya and Alberto Marulanda	98
The Outardes 2 Concrete-Faced Rockfill Dam O. Dascal	121
Concrete Face Rockfill Dams of the Winneke Project R. Casinader and R. E. Watt	140
The R. D. Bailey Dam—A Concrete-Faced, Earth-Rockfill Ralph R. W. Beene and Edward C. Pritchett	163
Foz do Areia Dam—Design, Construction, and Behaviour Nelson L. de S. Pinto, Pedro L. Marques Filho, and Edilberto Maurer	173
Construction of Foz do Areia Dam Bayardo Materon	192
Mangrove Creek Dam: Use of Soft Rock for Rockfill P. R. Mackenzie and L. A. McDonald	208
Design and Performance of Shiroro Rockfill Dam William L. Bodtman, John D. Wyatt	231
Fortuna Concrete Face Rockfill Dam D. A. Perdomo, M. S. Vasilescu and E. A. Ferro	252
Design Features of Salvajina Dam Jesus M. Sierra, Carlos A. Ramirez, and Jorge E. Hacelas	266
Construction and Performance of Salvajina Dam Jorge Hacelas, Carlos A. Ramirez and Guillermo Regalado	286
Boondooma Dam R. L. Rogers	316
Khao Laem—A Concrete Face Rockfill Dam on Karst Somkuan Watakeekul, Gordon J. Roberts, and Andrew J. Coles	336
Design and Construction of Terror Lake Dam Michael Morris	362

Kotmale Dam and Observations on CFRD Edward M. Gosschalk and A. N. S. Kulasinghe	379
Batang Ai—Transition Zone P. R. Phillips	396
Design of Cirata Concrete Face Rockfill Dam Ivor L. Pinkerton, Soetomo Siswamidjono, and Yutaka Matsui	642

GENERAL PAPERS

Design of Concrete-Faced Rockfill Dams Mike D. Fitzpatrick, Bruce A. Cole, Frank L. Kmstler, and Bram P. Knoop	410
Construction of Concrete Face Rockfill Dams A. Varty, R. Boyle, E. Pritchard, and R. Gill	435
The Upstream Zone in Concrete-Face Rockfill Dams James L. Sherard	618
Seismic Design of Concrete Faced Rockfill Dams H. Bolton Seed, Raymond B. Seed, S. S. Lai, and B. Khamenehpour	459
Seismic Analysis of Concrete Face Rockfill Dams Gilles Bureau, Richard L. Volpe, Wolfgang H. Roth, and Takekazu Udaka	479
Design and Stability Evaluation of Balsam Meadow Dam Chan-Feng Tsai, Bing C. Yen, Keith D. Tucker, and Shahen Askari	509
A Study of Deformations in Concrete Faced Rockfill Dams Hideo Imaizumi, Alvira Sardinha	528

DAMS IN DESIGN

Design of Deer Creek Dam Harold Hollingsworth, Timothy R. Conner, and Victor E. Anderson	541
The Xingo Rockfill Dam Aurelio A. Vasconcelos, Lutz Paulo Eigenheer	559
Rockfill Compression Tests and Other Aspects of the Design of Miel I Dam Juan E. Pineros	566
Segredo Dam—Basic Design Aspects Nelson L. de S. Pinto, Pedro L. Marques Filho, and Edilberto Maurer	587
Machadinho Dam in Brazil Regis Danton Correa and Fernando Thielen	594
Ita Dam—Selection of Type Jose Antunes Sobrinho and Joaquim C. da Cunha	601
The Design of Macagua Concrete Face Rockfill Dam Z. Prusza, K. De Fries, F. Luque	608
Subject Index	657
Author Index	658

PERFORMANCE OF COGOTI DAM UNDER SEISMIC LOADING

by Luis Arrau,¹ Ismael Ibarra,²
and Guillermo Noguera³

ABSTRACT: At the time of its completion in 1938, the 280 ft (85 m) high Cogoti concrete face rockfill dam was exceeded in height by only one other dam of its type in the world, Salt Springs Dam. The dam contains 915,000 cu yd (700,000 m³) of dumped rockfill, and the total area of the face slab is 172,000 sq ft (16,000 m²). Cogoti Dam is located in north central Chile approximately 170 miles (275 km) north of Santiago. Due to the remote location from major sources of cement and availability of rock, a concrete face rockfill dam design was selected. Since the completion of Cogoti, central Chile has been subjected to four major earthquakes ranging from 7.1 to 7.9 Richter. The 1943 earthquake (7.9 Richter) with epicenter 55 miles distance was the most severe with ground acceleration at the dam site estimated at 0.19 g. Although Cogoti was constructed of high-lift dumped rockfill without compaction or sluicing, no earthquake damage to the face slab has occurred. Substantial settlement did occur, but the dam is considered effective in withstanding seismic loadings.

Introduction

In numerous publications the Cogoti Dam has been reported as having been subject to important seismic loadings. These references name the Cogoti Dam but do not describe its design, construction, and performance details. The purpose of this paper is to provide such information and to evaluate the dam's performance under important seismic loadings.

¹ Civil Engineer, Depto. de Riego, Direccion General de Obras Publicas, Santiago, Chile

² Civil Engineering Student, Fac. de Ciencias Fisicas y Matematicas, Universidad de Chile, Santiago, Chile

³ Civil Engineer, Empresa Nacional de Electricidad S.A. - ENDESA, Santiago, Chile