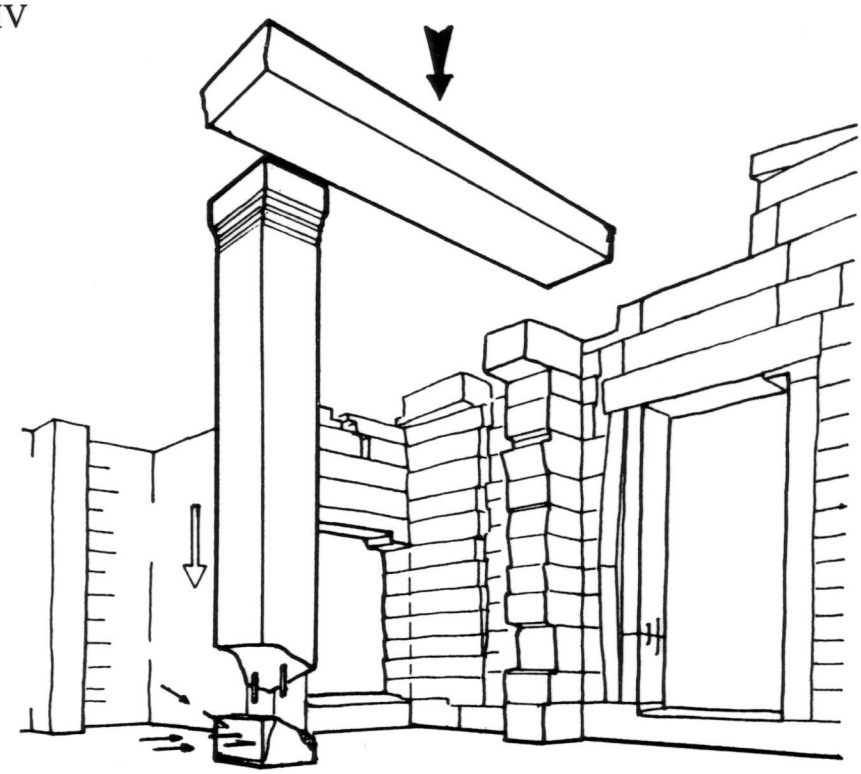
PREAH KHAN CONSERVATION PROJECT

HISTORIC CITY OF ANGKOR

Siem Reap, Cambodia

REPORT VII
FIELD CAMPAIGN IV



April 1, 1997

The World Monuments Fund, New York

Preah Khan Conservation Project
Historic City of Angkor

Siem Reap, Cambodia

Report VII
Field Campaign IV

April 1, 1997

cover graphic: Central Buddhist Complex, broken column at east corner of the central tower, scheme for consolidation

© The World Monuments Fund
ISBN: 0-9627931-9-1

DEDICATION TO MOROM 1966-1996

Those of you who have visited the Preah Khan project at Angkor and spent time at the WMF house there will remember dear Morom, who passed away on 21 March 1996 at the age of thirty. Morom, who died after a short illness, was one of the three Cambodian housekeepers who look after the WMF team in Siem Reap – an inseparable trio famed for their great cooking, kindness, and hospitality. Morom will be remembered for her great sense of humor, her zest for life, and her skills as a karaoke singer–many an evening her amplified voice would waft through the village of Wat Bo! We will all miss her sense of fun and laughter that forever echoed through the house.

Being without parents and family, Morom was 'adopted' by the WMF team. She often referred to me and my wife Jenna as her foster parents. We indeed assumed this role during the very moving traditional Buddhist funeral ceremony attended also by the WMF household, Preah Khan work force, and many hundreds of the village inhabitants. Morom departed this world in peace, and we are assured by the Buddhist monks who officiated at her funeral that she is happy in her new life. This report is dedicated to her memory.

John Sanday

& the Preah Khan Project Team

TABLE OF CONTENTS

PREFACE

Conservation, repair and stabilization activities at Preah Khan have continued to progress following the World Monuments Fund's well established work plan. The work force has been increased by eight additional locally hired staff members and now includes about 60 workers. The five students under the guidance of the WMF team have now joined the permenant staff as full time assistants following their graduation from the architecture program at the University of Phnom Penh.

This report for report VII, field campaign IV documents work undertaken at Preah Khan from October 1995 to July 1996 and continues the series of annual summaries of work at Preah Khan as part of the ten-year intervention planned by the World Monuments Fund and the International Coordinating Committee for the Safeguarding and Development of the Historic City of Angkor (ICC). The work year for our team at Preah Khan is from October to July in accordance with the heavy rains; many of the work force must also tend their own fields on which their families rely. These reports provide a record of the activities, discoveries, and challenges which have been a part of conservation work at Preah Khan; our understanding of Preah Khan has changed as new information comes to light and our methods improve with the maturation of the training program in stone conservation and emergency repair.

Complete documentation of our ongoing activities is available through the World Monuments Fund office in New York; this volume summarizes the major accomplishments to date and sets forth our conservation and training objectives for the coming year.

-- John Sanday
Project Manager, Preah Khan Conservation Program

ACKNOWLEDGEMENTS

The World Monuments Fund is grateful to an increasing number of individuals who have served and continue to serve as members of the Preah Khan Field Missions and to the experts who have produced and reviewed this report.

The Preah Khan Conservation Consultant Team for Field Campaign IV consisted of the following consultants:

John Sanday, Project Director, WMF Representative in Cambodia
John Stubbs, Vice President for Programs, WMF New York
Predrag Gavrilovic, Structural Engineer
Paolo Pagnin, Conservator/Restorer
Caroline Schweyer, architect in charge of records

WMF and the consultant team are continually impressed by and appreciative of the hard work and dedication shown by the team of students associated with the Departments of Architecture and Archaeology from the University of Phnom Penh. During this field campaign, the students produced an excellent set of record drawings under the guidance of documentation specialist Caroline Schweyer. This team of students was comprised of architects who have previously participated on site: Mr. Lek Sareth, Mr. Var Morin, Ms. Cheam Phally, Ms. Chhun Soma, and a newcomer, Mr. Sam Kimheng. The team also included returning archaeologist Mr. Chan Chamroen, and Mr. Nay Sophea. WMF especially wishes to thank Dean Sophean of the Department of Architecture for his help and insight. Contributions to this report have also been provided by WMF headquarters in New York, from President, Bonnie Burnham, and staff members Rebecca Anderson, Daniel Burke, Felicia Mayro, and Monika Riely. Jon Calame produced this report.

Special thanks are expressed to our hosts: the Royal Cambodian Government, and in particular to His Majesty King Norodom Sihanouk; H.E. Vann Molyvann, Minister of State; H.E. Son Soubert; H.E. Nouth Narang, Minister of Culture and Fine Arts; and other members of the ministry including Under Secretary Mr. Michel Tranet, National Museum Director Mr. Pich Keo, and Cultural Adviser Mr. Ouk Chea.

WMF would like to express its gratitude to Governor Ton Chay of Siem Reap Province for his support of the Preah Khan Conservation Project; to Mr. Uong Von, Director of the Conservation d'Angkor in Siem Reap, for his constant support and advice. Gratitude is also extended to the staff of the Conservation d'Angkor.

Following its participation in the meeting of the International Coordinating Committee, WMF would like to express its gratitude to the Co-Chairmen of the Committee: The Honorable Yukio Imagawa, Ambassador of Japan to Cambodia, and The Honorable Gildas Le Lidec, Ambassador of France to Cambodia; to the UNESCO Secretariat and representative Mr. Khamliene Nhouyvanisvong; and to all the teams working at Angkor for their cooperation, advice, and support. WMF would also like to extend its appreciation to the UNESCO staff in Paris, especially Minja Yang.

Special thanks go to WMF's local administration team and work force ably led by Project Assistant Kussom Sarun, with special mention of the house staff at No.4 Wat Bo in Siem Reap. The Preah Khan work force, consisting of 50 masons, metalworkers, foremen and laborers, excelled throughout Field

Campaign IV and worked hard as a harmonious group. WMF thanks the entire project development team based in Cambodia for their contribution to the success of the project.

WMF's efforts have also been aided by important contributions from individuals acting on their own initiative, both in Cambodia and throughout the world. The ongoing conservation project has attracted a large number of visitors to Preah Khan who have continually offered assistance in the form of advice, funds, food, and medical supplies for the local team. For these thoughtful and generous deeds the Preah Khan Conservation Project team conveys its thanks.

The Preah Khan Conservation Project Team is especially grateful for the continuing support and encouragement of the Board of Trustees of the World Monuments Fund.

Sponsors

The World Monuments Fund is grateful to the many donors whose generous support sustains its efforts at Angkor, in particular the campaign to safeguard Preah Khan, one of the world's priceless resources. On the following page we recognize some of the many individuals, visitors to the site, and organizations whose assistance with the ongoing site conservation work has been most gratefully received.

Sponsors ($100,000 or more)

The American Express Foundation, Tokyo
The American Express Foundation, New York
Robert W. Wilson

Milestone Donors ($5,000 or more)

Anonymous
Asian Cultural Council
William C. Bannerman Foundation
British Embassy, Phnom Penh
The Brown Foundation
Government of Cambodia
Mrs. Jan Cowles
The Cowles Charitable Trust
Lois and George De Menil
Mr. and Mrs. Ralph Falk II
The Gilder Foundation
The Guide Foundation
Lydia Irwin
J.M. Kaplan Fund
Samuel H. Kress Foundation
Mr. George L. Lindemann,
Mr. and Mrs. Samuel C. Miller
The Norton Family Foundation
The Ralph E. Ogden Foundation
PATA Foundation
Ms. Nancy Richardson
Mr. Charles Robins, California
Dott. Rodrigo Rodriquez
The Royal Angkor Foundation
Barbara and Randall Smith
The Starr Foundation
United States Information Service, Phnom Penh
Nancy Brown Wellin

Contibutors ($1,000 or more)

Anonymous
Mr. and Mrs. Ephraim Baran
Ms. Susan L. Beningson
Ms. Margaret R. Bennett
Ms. Patti Cadby Birch
Mr. Gilbert de Botton
Mrs. Deborah L. Brice
Mrs. George W. Brown
Dr. Angela Cobra
Dr. and Mrs. John M. Cohen
Mr. David L. Davies & Mr. John D. Weeden
Mr. and Mrs. John D. Dennis
Mr. William A. Edmundson
Mr. and Mrs. Arthur D. Emil
Mr. and Mrs. Luis Farinha dos Santos
The Oliver R. Grace Charitable Foundation
Mr. Donald Herman
Elbrun and Peter Kimmelman Fund, Inc.
Ann and Gilbert Kinney
Roy and Dorothy Lichtenstein
Mr. and Mrs. M.O.L. Lynton
Mrs. Eugene McDermott
National Trust for Historic Preservation
Mrs. Linda Noe Laine
Mrs. Sylvia Owen
Cynthia and Leon Polsky
Mr. Khalil Riszk
Mr. and Mrs. Paul Sperry
Mr. Donald J. Sutherland
Mr. and Mrs. Rolf von Buren
The Miriam and Ira D. Wallach Foundation
Mr. and Mrs. Stanley Weiss
Mr. Hiram P. Williams, Jr.

Friends (up to $1000)

H.R. Ames
Mr. Lawrence C. Ames
Mr. and Mrs. Wayne R. Atwood
Mrs. Marion Becker
Mr. James I. Berliner
Mrs. Robert Bernstein
Mr. Clarence B. Blair
Ms. Adele Bodzin
Ms. Isabelle Bosquet
Ruth Bowman
Mr. J. Carter Brown
Mr. and Mrs. Peter H. Bunce
Ms. Therese Carpenter
Mr. and Mrs. Gilberto Charpenel
Mr. Robertson E. Collins
Mr. James Patrick Cooney
Mary Eather and Henry Dasenbrock
Princesse Noelle Del Drago
Ms. Helen B. Dennis
Mrs. Fleur Eng-Reeves
Ms. Beatrice K. Feldman
Ms. Frances Fitzgerald
Mr. Peter Fleming
Mr. Ronald Lee Fleming
Contessa Barbara Foscari Widmann Rezzonico
Mr. and Mrs. Walter Frank
Mrs. Helena Fraser
Mr. Robert J. Geniesse
Mr. Robert J. Gervais
Mr. and Mrs. Peter Goldmark
Mrs. Ann L. Gray
Mr. and Mrs. Allen B. Harbach
Mr. Andrew T. Hass
Ms. Charlotte Hill
Ms. Barbara Hoffman
Ms. Carolyn Houghton
Mr. and Mrs. Philip Jessup, Jr.
Mr. Jack A. Josephson
Barbara Joyce Kaye
Mr. and Mrs. Sheldon Kent
Mrs. Anne Kratz
Mr. and Mrs. Walter Kudlick
Mr. Michael I. Leonard
Dr. Benjamin F. Levine
The Sydney and Frances Lewis Foundation
Mr. and Mrs. Walter S. McLucas
Mrs. Helen Maguire Muller
Mr. Eric R. Nelson
John Julius Norwich
The Harris K. and Lois G. Oppenheimer Foundation
Mrs. Catherine Ortiz
Mr. David Owlsley
Ms. Victoria Chan Palay
Dr. Marilyn Perry
Ms. Stella Pettus
Mr. Frederic P. Putnam
Dr. Dawn Rooney
Ms. Jane Scarriot
Mr. and Mrs. Roberto Schezen
Mr. Lowell M. Schulman
Ms. Suzanne F. Silvers
Mr. and Mrs. Sichan Siv
Bill Smith Studio
Ms. Sally E. Wallner
Mrs. Josephine McCarthy Wilson
Mr. Robert K. Wineland

SECTION 1

The World Monuments Fund in Angkor: 1990-2000

1.1 TEN YEAR CAMPAIGN MIDTERM REVIEW

1996 marked the midpoint of WMF's involvement at Preah Khan, and the previous campaign reports submitted to the *International Coordinating Committee on the Safeguarding and Development of the Historic Site of Angkor* testify to the scope and effectiveness of our efforts there to date.

This midterm report allows for some reflection on the continuing evolution of our role as a sponsoring institution operating on foreign soil. With physical conservation activities thoroughly defined and in mature stages of implementation, our focus has steadily shifted from the immediate needs of the historic structures towards a long-term maintenance scheme for the site as a whole, which will require careful, continuous, and professional stewardship on a permanent basis. To this end, our interests will dwell increasingly on the success of the education and training components of the Preah Khan program, detailed elsewhere in this report. These projects—ranging from space-borne radar imaging to architectural training for Cambodian students—allow us to improve the depth of understanding of the site along with the quality of the conservation team responsible for Preah Khan after the WMF's work is concluded.

The World Monuments Fund, as a central part of its long-term mission at Preah Khan, continues to invest in the human resources at the site through staff training and education. This type of investment will surely prove to be the most important and lasting contribution we can make to the longevity of the Cambodian cultural patrimony and the health of the communities to which it belongs. In the next few years all of the major structural interventions undertaken by WMF at the Preah Khan complex will come to a close, and we will leave to future generations the many structures—some of which may yet be undiscovered—which remain untouched and in need of careful conservation. Pending projects include the repair of the Dharmasala structure, already documented by the WMF team, and the rehabilitation of a significant tower shrine on the site's central axis.

Meanwhile, fundraising will continue in the interest of all these initiatives until the conclusion of our direct involvement at the site in the year 2000. The needs, as always, are great. It is currently estimated that $600,000 is required to bring the projects already in process to completion at Preah Khan, and it is hoped that an endowment to support the permanent Cambodian staff might develop from the "Adopt-A-Garuda" program which is already underway. Increasingly, with the success of on-site tours and tee-shirt sales at the visitors' kiosk, the Preah Khan site might be able to support its own conservation activities to a significant extent. The World Monuments Fund will continue to be a primary advocate for Preah Khan in the realms of research and philanthropic giving.

More than half way through our mission, WMF is pleased with the results which have been achieved under the able guidance of John Sanday and the dedicated Cambodian team. Under difficult conditions, both social and financial, a great deal of work has been completed to date which is of the highest professional quality and integrity. Interest in the site has been generated through innovative research and international fundrasing; this interest will inevitably result in lasting alliances which were unimaginable at the outset of this decade-long program of conservation and training. It has been our desire to exert a positive influence on the site and the surrounding community of Siem Reap, and we will remain committed to this goal up to and beyond the conclusion of our tenure at Preah Khan.

-- Bonnie Burnham, President
World Monuments Fund

1.2 History Of The World Monuments Fund Preah Khan Project

Sketch History & Description Of Preah Khan

In its present state, Preah Khan is best described as a partial ruin set deep in the jungle of north central Cambodia. It is one of the few temple complexes at Angkor which is still totally surrounded by jungle. The coexistence of these historically significant man-made remains and its relatively untouched natural setting makes Preah Khan one of the outstanding sites at Angkor.

Preah Khan, covering approximately 56 hectares, is an extensive building complex within the Historic City of Angkor, located a short distance beyond the North Gate of the Angkor Thom precinct. It was built by the Khmer King Jayavarman VII as a monastery and teaching complex. Preah Khan is the most prominent of several temple complexes associated with the Northern Baray (often referred to as the Preah Khan Baray), which stretches approximately four kilometers eastward and links Preah Khan with the contemporaneous sites of Neak Pean and Ta Som. This group, one of Angkor's major urbanistic conceptions, once formed a major part of Angkor's vast hydrological system, which is now largely in disuse.

According to the Preah Khan stele (see appendix, section 3.1), the site was dedicated in A.D. 1191. Over the next three centuries the temple complex was modified considerably. Four concentric enclosure walls subdivide the monastic complex. The outer wall is encircled by a wide moat, which today encloses a large tract of jungle. This area was formerly the living quarters of the monks and attendants of Preah Khan. The second enclosure wall delineates the principal religious compound, within which temples and shrines dedicated to the Hindu sects of Vishnu (West) and Shiva (North) are densely concentrated. The central shrine is Buddhist, the southern quadrants are dedicated to ancestor worship, and the eastern axis forms a grand approach to the principal Buddhist shrine in the center.

Like most of the monuments of Angkor, Preah Khan is in a state of ruin following a slow decline in royal patronage beginning in the middle of the 15th century. While evidence suggests that some of the temples and shrines remained in use (probably until the end of the 17th century), it was not until the end of the 19th century that Preah Khan, like many other temples at Angkor, was 'rediscovered' by the Ecole Française d'Extreme Orient (EFEO). EFEO's work is well documented and archived both in Cambodia at the National Museum in Phnom Penh and in Paris; records are available in the form of transcriptions and microfiche.

Preah Khan Project Goals

The World Monuments Fund (WMF) fielded its first mission to Angkor in December 1989. By November 1992, WMF had mobilized a team of craftsmen and laborers to commence its program of on-site activities at Preah Khan. Mission I in 1989 represented the commencement of a projected 10-year commitment to assist the Royal Cambodian Government and UNESCO by contributing to the International Campaign to Safeguard Angkor. See previous reports Volume I — *Conservation Considerations for the Historic City of Angkor* (1992) and Volume II—*Preah Khan, Project Identification* (1993).

In preceding reports, WMF recommended a course of action at Preah Khan which was subsequently approved by Cambodian authorities and the ICC. The development of basic conservation principles

and procedures guides the WMF team and its work force in a long-term program to repair, conserve and present Preah Khan as a partial ruin. Due to the magnitude of the task, major reconstruction is not to be undertaken at Preah Khan, which is presented to the public as an exposed archaeological and architectural ruin. In addition, judicious jungle clearance, debris removal and on-site interpretive aids have made Preah Khan more physically and visually accessible and its rich history more intelligible to visitors. WMF seeks to pass Preah Khan on to future generations in a state similar to that in which it was found, but with the added assurances that, by using modern conservation technology, the site will be rendered structurally sound and the natural environment will be sustained.

Since 1991, WMF has advocated and administered an on-site training program for Cambodian students students of architecture and archaeology from the University of Fine Arts, Phnom Penh in recognition of the Preah Khan's value as a conservation training laboratory. During the 1995/96 Field Campaign IV, the graduate students trained under this program were integrated into WMF's professional team. Part of this training is being directed at the craftsmen who are also taught appropriate conservation skills as an extension of the local craft tradition.

World Monuments Fund at Angkor

The World Monuments Fund (WMF) sent its initial field mission to Cambodia in December 1989 to survey Angkor and evaluate the damage the site had suffered after 20 years of civil strife and isolation. The mission soon discovered that the temples were relatively unaffected by the upheavals that shook Cambodia. Angkor's caretakers, however, were not as fortunate. Among the educated Cambodians to die in the "killing fields" were those with specialized training in architectural conservation. By the time the Khmer Rouge were ousted from power in late 1978, only a handful of the former workers at Angkor had survived. While the country remained isolated for more than a decade after the overthrow of the Khmer Rouge, the site was virtually unattended and the French conservation facility was in shambles.

When WMF visited Angkor in 1989, the Cambodian government urged its team to organize a pilot project to address some of the challenges facing preservationists at Angkor; the site selected by WMF for this undertaking was Preah Khan, a 12th-century Buddhist monastic complex. WMF has since conducted regular field missions to the site, under the supervision of Project Manager John Sanday, a conservation architect with expertise in Asian structures who has has been a consultant to WMF since the late 1970s.

Philosophy and Approach

WMF's philosophy at Angkor is based on a dual challenge: to preserve a magnificent heritage site and to insure that its Cambodian custodians possess the expertise required for its care and management. Initial surveys of the site led WMF to construct a long-term program to repair and conserve the site as a partial ruin. Major reconstruction was not judged appropriate due to the lack of historical data, the magnitude of the task, and the questionable philosophical nature of such an approach

WMF also intends for its work at Angkor to help support the restoration of peace and prosperity in Cambodia. It strives not only to preserve Angkor, the country's most cherished symbol of identity and its touchstone to the past, but also to strengthen the sense of stability and security in the local population by providing jobs, new expertise, and contact with the outside world.

The World Monuments Fund's Comprehensive Approach To Conservation At Angkor:

- Establish conservation methodologies which are appropriate for use at Khmer monuments and analyze building materials to determine how to resolve problems related to their use and conservation.

- Stabilize and partially consolidate structures at locations within the Preah Khan complex.

- Recommend ways to protect and properly present the historic monuments at Preah Khan and its environs.

- Emphasize formal on-site conservation training for Cambodian architecture and archaeology students and for local craftsmen.

- Seek to ensure the protection of Angkor's movable cultural property by deterring theft and vandalism, using video imaging and site-specific computerized inventories to document the architectural sculpture at Preah Khan.

- Conduct above-ground archaeological research at Angkor to learn more about the ancient Khmer empire and Angkor's prehistory.

1.3 PREVIOUS CAMPAIGN ACCOMPLISHMENTS

Field Campaign I (1992-1993)

The first extended Field Campaign at Preah Khan, from October 1992 to April 1993, initiated the project's conservation plan. This campaign consisted of three principal field missions of WMF consultants as well as continuous on site work by laborers.

In March 1993, WMF brought five consultants to the site to conduct a documentation and materials testing program. This led to the development of policies for structural repair, consolidation and planning to be further advanced the following year. *For more detailed information, please see Preah Khan Conservation Project Report IV: Field Campaign I — Project Mobilization, including three separate appendices.*

Field Campaign II (1993-1994)

Field Campaign II, which ran from November 1993 to May 1994, consisted of three separate missions, which began with site clearance and preparation for the technical team's arrival in January.

During the first mission in January 1994, a nine-member team initiated the following projects: cleaning, repair and maintenance of stonework; structural testing, repairs and consolidation at the South Portico of East Gopura III, the Hall of Dancers, and the Lanterns (Bornes) along the West Processional Way; survey of the natural environment; and graphic and photographic documentation for architectural, archeological, engineering and interpretation purposes.

During the second mission, in March 1994, the team completed work begun earlier in the campaign and initiated new activities, including structural repairs and archeological soundings. Also, work began on the production of an annual report of WMF's accomplishments at Angkor.

The third mission was conducted in April 1994. Preah Khan Project Manager John Sanday and WMF team members participated in the filming of the U.S.-based Discovery Channel's *The Struggle for Angkor*, which demonstrates present-day efforts to conserve the monuments of Angkor; the documentary aired in October 1994.

Based on its experience at Preah Khan and by arrangement with the Royal Cambodian Government, WMF began general maintenance work at nearby Prasat Neak Pean, located in the center of the Preah Khan baray, and proposed possible conservation and protection interventions at other sites within the Historic City of Angkor. This same year, a group of Preah Khan students prepared their final architectural diploma projects on the Neak Pean complex.

Field Campaign III (1994-1995)

Preah Khan Field Campaign III commenced after the rainy season in October 1994. Efforts during this period concentrated more than in previous years on interventions for structural consolidation, in particular to prevent several imminent collapses and to make the site safer for visitors.

Project Manager John Sanday visited Siem Reap with specialist Sharosh Pradhan to commence preliminary analyses of possible applications for computer-aided design (Autocad) at Preah Khan. Sanday returned to the site in December to introduce volunteer Andrew Dennis to the project and prepare for the arrival of a group of 24 visiting sponsors from the World Monuments Fund in New York and the first mission in January 1995.

The first mission, January 2-22, overlapped with a WMF sponsors' visit. After preparing work plans with each of the consultants, Sanday joined WMF Vice President for Programs John Stubbs, WMF Chairman Marilyn Perry, and WMF Board of Trustees Secretary Robert Geniesse at a conference entitled *The Future of Asia's Past* sponsored by The Asia Society in Chiang Mai, Thailand.

As part of its ongoing participation in to the campaign to safeguard Angkor, WMF, in conjunction with the Royal Angkor Foundation (RAF), introduced radar images of the entire Historic City of Angkor as provided by the National Aeronautics and Space Administration's Jet Propulsion Laboratory. Taken by the space shuttle Endeavour during its April and October 1994 flights, these images are valuable new resources for the documentation and analysis of Angkor. With the support of the J.M. Kaplan Fund, Inc., WMF and RAF organized a scientific roundtable in February 1995 in Princeton, New Jersey to discuss space-borne radar imaging and its applications at Angkor. *A report on the conference entitled* Radar Imaging Survey of the Angkor Eco-Site *was printed in March 1995.*

During the second field mission, the team of consultants and the Preah Khan work force concentrated on the systematic consolidation of structures along the principle axial route originating at the East Gopura IV and the central gateway in particular. Since the de-mining and clearance of the original east access road along the boundary between Preah Khan and the North (Preah Khan) Baray, it is now possible to enter the site from the East or principal entrance. Priority was given to the consolidation and partial reconstruction of the North West Portico at East Gopura IV, which was on the point of collapse. In the Hall of Dancers, located on the main east/west axial route within the temple complex proper, the consultant team identified the south east sector of the hall as being in need of urgent consolidation — a choice which was justified as the extant quarter vaults were also threatening collapse.

SECTION 2

Campaign IV: 1995-1996

2.1 CAMPAIGN IV: SUMMARY OF ACCOMPLISHMENTS

Physical Conservation

Previous campaigns surveyed and prioritized many physical conservation projects at Preah Khan; this year many of those projects matured or reached completion. The specific areas and structures where ongoing interventions occurred are:

section / site	intervention zone	actions
1 East Gopura IV	central gate entrance and tower, south tower, northeast tower and portico	*survey and drawing, structural consolidation, resetting of vaults*
2 Hall of Dancers	southeast sector wall, southern causeway, northeast sector	*consolidation of columns and lintels, survey, stone repair*
3 Enclosure Wall IV	northeast sector, southeast sector	*reconstruction, stabilization, stone recutting and setting, insertion of new foundation*
4 Garuda engaged statuary	NE31, NE35 ("Brewer"), NE36	*survey, drawing, dismantling, repair, consolidation*
5 Central Buddhist Complex: southwest courtyard	central tower, northeast shrine	*interior survey and cleaning, tree clearance, stone repair*
6 West Gopura III	'Dvarapala' statue: South	*consolidation, repair, repointing*
7 Northeast 'Dharmasala' Pavilion		*survey, emergency support, consolidation*

Specific conservation actions will be detailed in subsequent sections of this report.

Staff Training

Research and training activities also expanded in the last year in anticipation of the eventual inheritance of the project by an entirely Cambodian professional staff. Training was facilitated by the presence of two foreign experts: Paolo Pagnin of Italy instructed Cambodian staff in appropriate techniques for stone consolidation, put to use immediately on the broken southern Dvarapala statue at the west Gopura III; Dr. Predrag Gavrilovic of the Institute of Earthquake and Engineering Seismology in Macedonia offered his expertise on emergency structural repairs and reinforcement for load bearing stone masonry. Following training sessions with these visiting experts, the full time staff was able to replicate the new techniques successfully and improved results were clearly evident.

Three on-site interns–the second group of architectural students from Phnom Penh University to be trained in conservation at Preah Khan–graduated successfully on January 27, 1996; their thesis work involved numerous projects relating to the short and long term conservation of Neak Pean Temple and that site's important hydrological features. Phally, Soma, and Heng joined the Preah Khan Conservation Project as paid full time assistant architects in March. Architect Van Maurin, who graduated in December 1995, also joined the regular staff in January.

Preah Khan staff have been in contact with the Dean of the Architecture School at the University of Phnom Penh, Phoueng Sophean, who proposed an expansion of the internship and conservation training activities offered as part of the World Monuments Fund program. A proposal was made for the induction of 4-5 new student interns and the organization, with the assistance and support of the faculty, of a month-long 'stage', or field course, for a larger group of students which would be added to the permanent curriculum. These recommendations will be considered during the June 1997 planning meeting in New York.

New Directions in Research

Stone Conservation

The efforts of visiting experts Pagnin and Gavrilovic brought to light numerous techniques for gluing, pinning, and doweling broken stone elements which had never been used by the Preah Khan team before; these advances were made through the selection of experimental projects designed to test the ease and efficacy of their application under field conditions. The resulting documentation and capacity enhancement have formed a lasting contribution to the site.

Archive Development

Assistant architect Caroline Schweyer from France spent five months at Preah Khan, and during that time completed the modification of commercial Access II software for storage of the Preah Khan archive of architectural drawings and photographs which has been underway since 1992; her efforts have generated a systematic storage and retrieval system which will greatly facilitate research and enhance efficiency of the overall documentation program (*see appendix 3.3*). This digital database will allow drawings to be tracked according to number, date, location, size, and type. All drawings have been reproduced at A3 size for consistency and ease of handling. Ms. Schweyer also developed a photographic database for the Preah Khan prints archive.

Second Scientific Roundtable

On October 4, 1994, the astronauts of the U.S. space shuttle Endeavour (SRL-2) orbited their craft on a path that would take them across southern Thailand, above the Dangrek mountains of northern Cambodia, over the ruins of the Historic City of Angkor, past the Cambodian capital of Phnom Penh, and down the Mekong River to the Mekong Delta and the South China Sea. Housed in the payload bay of the space shuttle was a sophisticated space-borne radar-imaging laboratory which, as the shuttle passed silently over Cambodia, was activated to take pictures of the former capital of the Khmer Empire. *For details, see separate WMF report* "Radar Imaging Survey of the Angkor Eco-Site".

In two passes over Angkor, the Endeavour collected a wealth of radar data on its SIR-C/X-SAR Earth Imaging Radar system, a laboratory that is unique in that it uses three radar frequencies to penetrate different levels of the earth's atmospheric, biological, and surface covers. The Endeavour collected an enormous amount of data on the archaeological and ecological sites at Angkor, to assist in the documentation and analysis of the ancient capital. In February 1995 a scientific roundtable entitled "Radar Imaging Survey of the Angkor Eco–Site" was held at Princeton University and sponsored by WMF in order to examine the findings which resulted from the NASA mission.

During campaign IV, a second scientific roundtable entitled "Workshop and Symposium on Radar Imaging and Cultural Resource Management at the Angkor Eco–Site" was hosted by the University of Florida, Gainesville on April 15–19, 1996 to synthesize the various discoveries and advancements made over the last year. *For further details, see Florida report executive summary, section 2.3.3.*

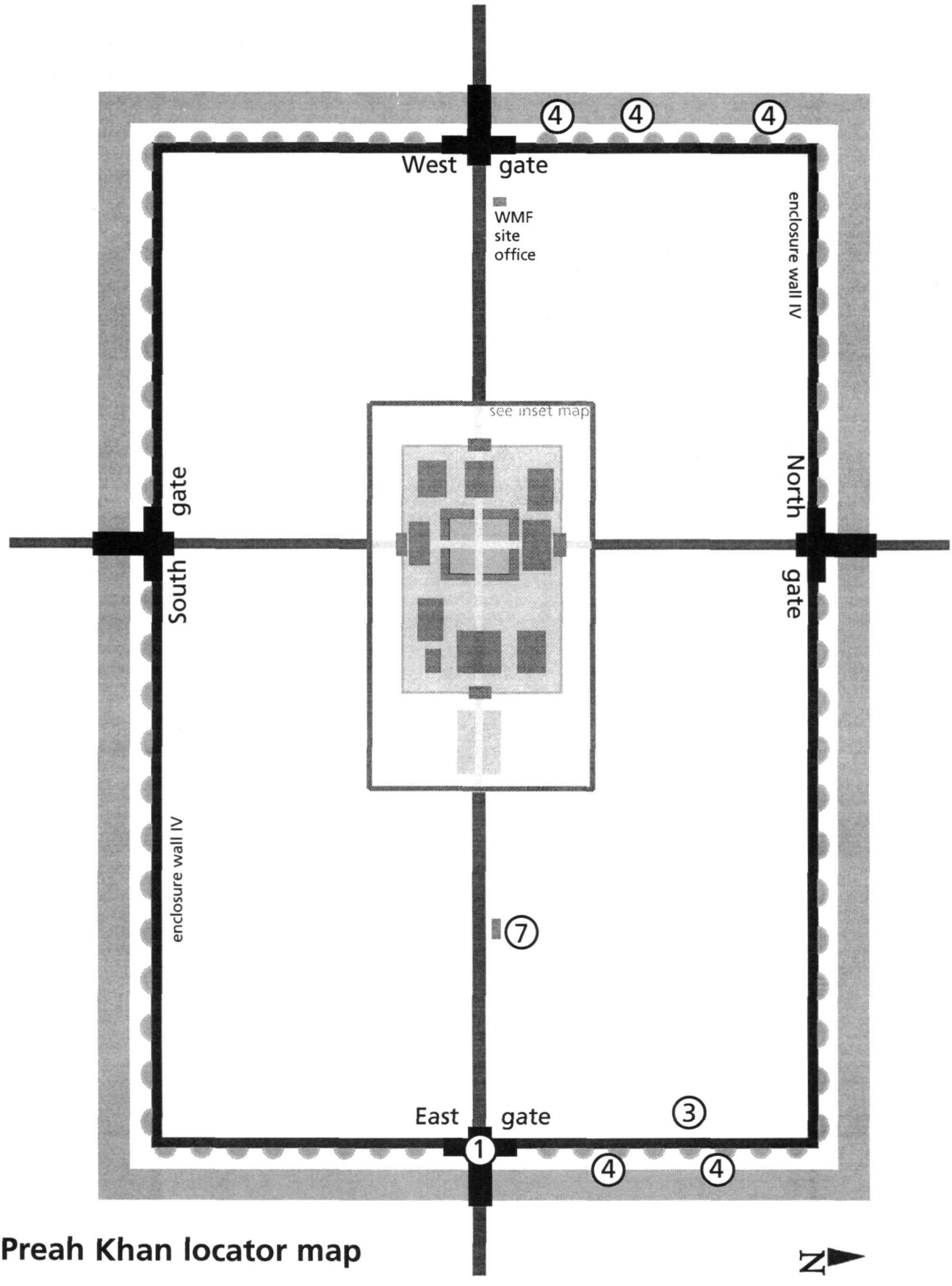
The workshop focused on radar imaging as a potential framework for all available remote sensing, land survey, and other relevant scientific data gathered at the Eco–Site of Angkor. Hosted by the Department of Architecture and the GeoPlan Center computer laboratory within the University, the workshop provided an opportunity for hands–on analysis of radar data and subsequent group discussion among scientists, diplomats, and Angkor experts. The roundtable included symposium and workshop components.

The symposium on "New Technologies and Global Cultural Resource Management" was called to examine the use of radar imaging in cultural resource management worldwide. Presentations were delivered on the management of sites other than Angkor, such as Chaco Canyon; desert regions in Egypt; Nikopolis in northwestern Greece; ancient Metapontum in southern Italy; Chersonesos in Sevastopal, Ukraine; and Mt. Kinabalu in Borneo. The common theme was the role of remote sensing in current archaeological work and cultural resources management. Having heard the latest information on the results of spaceborne radar imaging of Angkor presented during the workshop, the symposium participants addressed the potential use of space and airborne remote sensing as well as traditional and modern land survey methodologies for monitoring a variety of cultural, natural, and combined heritage resources, including World Heritage sites.

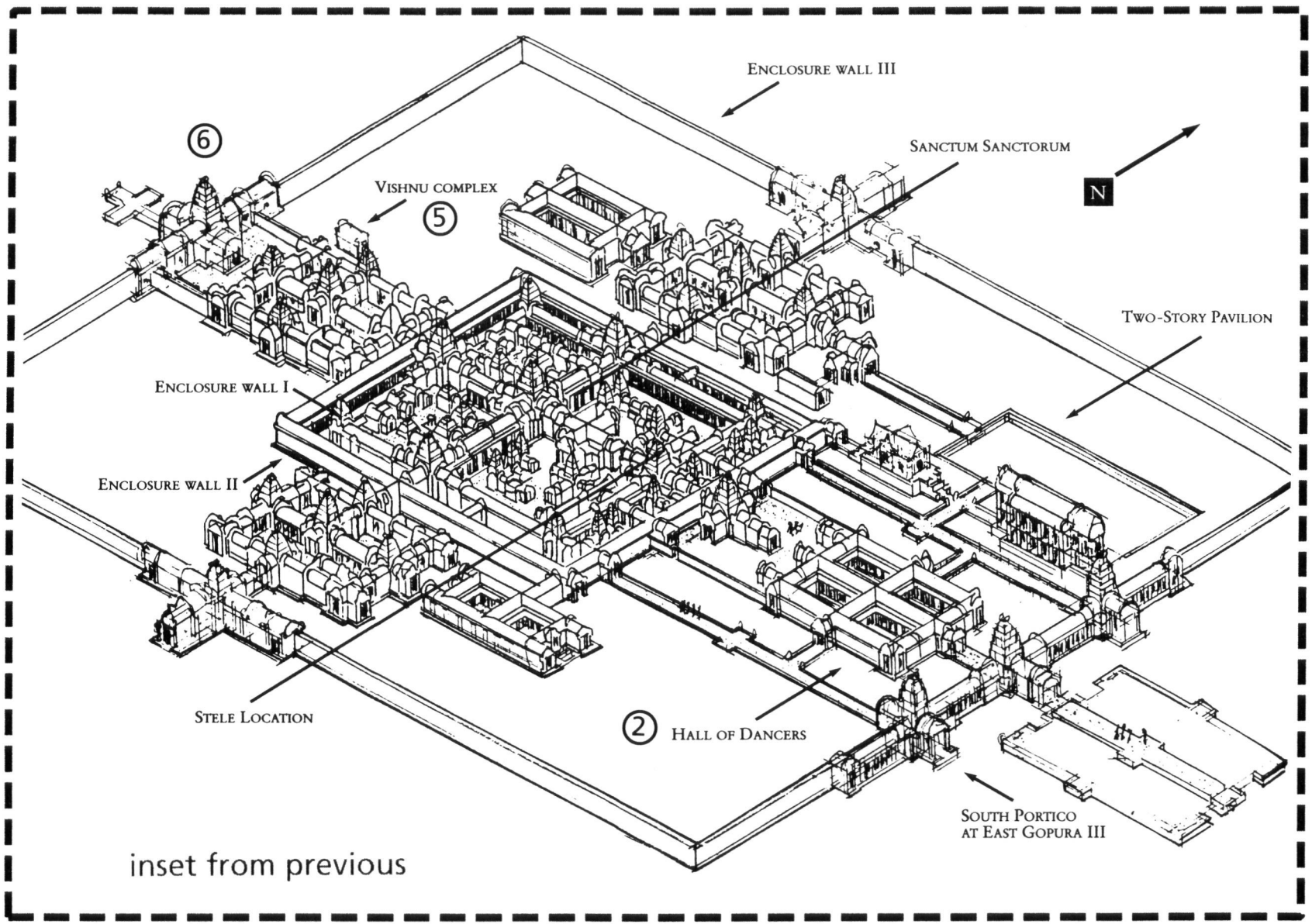
The workshop at the Second Scientific Roundtable provided a forum for discussion of progress made over the last year. Three main areas were explored: data management, prehistoric, historic, and archaeological discoveries, and ecological finds. Throughout these analyses, Angkor experts related their experiences using radar imaging as a new tool in their research. It is hoped that continuing research in this domain will lead to more effective field practices at Preah Khan.

- locator maps
- conservation project summaries

① East Gopura IV
② Hall of Dancers
③ Enclosure Wall IV
④ Garuda Engaged Statuary
⑤ Central Buddhist Complex: southwest courtyard
⑥ West Gopura III
⑦ Northeast 'Dharmasala' Pavilion



Preah Khan locator map


ENCLOSURE WALL III
SANCTUM SANCTORUM
N
⑥
VISHNU COMPLEX
⑤
TWO-STORY PAVILION
ENCLOSURE WALL I
ENCLOSURE WALL II
STELE LOCATION
② HALL OF DANCERS
SOUTH PORTICO
AT EAST GOPURA III
inset from previous

E. Gopura IV

2.2.1a .....plan and section of east side of north portico
2.2.1b .....east side of north portico, wall section showing reinforcement
2.2.1c .....east side of north portico, south and north elevations
2.2.1d .....east side of north portico, south and north section and elevation showing repaired masonry
2.2.1e .....east side of north portico, masonry repair and reinforcement details
2.2.1f .....northeast portico photographs
2.2.1g .....northeast portico tower before and after repair and consolidation

Hall Of Dancers

2.2.2a .....east entrance, plan before and after excavation of loose stone
2.2.2b .....east wall, southeast quadrant, dismantled and reconstructed areas
2.2.2c .....southeast quadrant, section of dismantled and reconstructed wall
2.2.2d .....southeast quadrant, section of dismantled and reconstructed wall, working drawing

Enclosure Wall IV

2.2.3a .....northeast section, proposed repair and reinforcement
2.2.3b .....northeast section, existing conditions
2.2.3c .....northeast section, proposal for masonry linkage of reconstructed sections with steel clamps
2.2.3d .....foundation replacement work underway
2.2.3e .....foundation replacement work underway

Garuda Engaged Statuary

2.2.4a .....Garuda NE35, profile view after infill and restoration
2.2.4b .....Garuda NE35, section and elevation showing repairs and clamps
2.2.4c .....Garuda NW1, survey and numbering drawing showing termite infestations
2.2.4d .....Garuda NE35, survey and numbering

Central Buddhist Complex

2.2.5a .....broken column at east corner of the central tower, scheme for consolidation
2.2.5b .....location of fallen trees in southwest quadrant

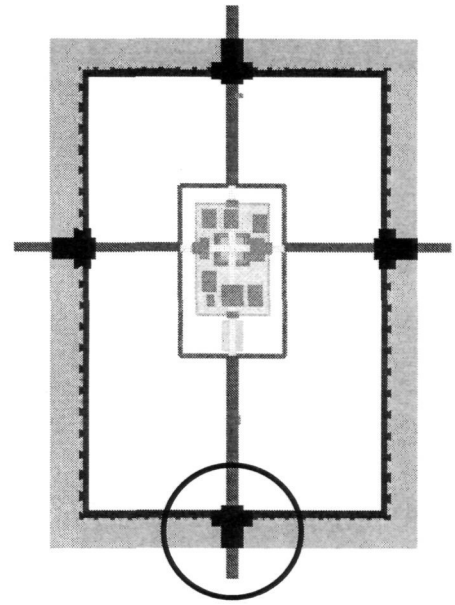
West Gopura III: Dvarapala

2.2.6a .....south Dvarapala, as found condition
2.2.6b .....south Dvarapala, repair and strengthening

Northeast Dharmasala Structure

2.2.7a .....plan with proposed reinforcement
2.2.7b .....sections through corbelled vaults showing proposed consolidation
2.2.7c .....existing state of monument, exterior view
2.2.7d .....eastern section of monument, exterior view
2.2.7e .....western section of monument, exterior
2.2.7f .....western section of monument, interior
2.2.7g .....proposed interventions

2.2.1 EAST GOPURA IV



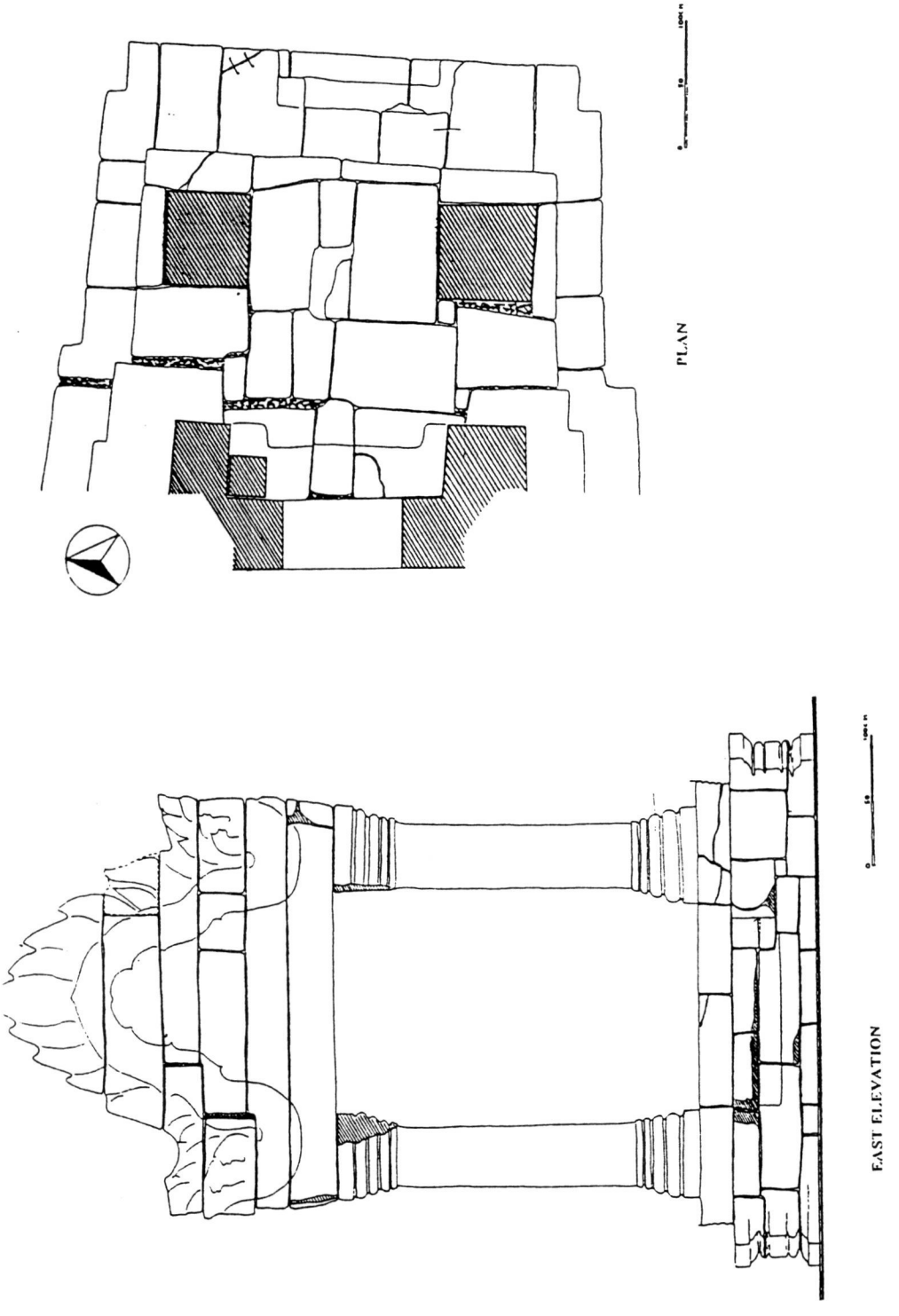
The East Gopura IV is the principle gateway to Preah Khan from the east, where it passes through the outer enclosure wall. The gopura shows the typical triadic arrangement of passageways, built on the axes of the temple complex, and is fast becoming the most popular entrance for visitors. This project was originally selected for intervention because it would provide useful examples of consolidation interventions for the repair of vaults and splicing new pieces of stone onto a lintel. *For previous studies and surveys, please refer to Preah Khan Report VI, section 5 and Report V, section 4.*

During Campaign IV, detailed survey drawings in plan and section of the complex continued to be produced. The following conservation actions were undertaken:

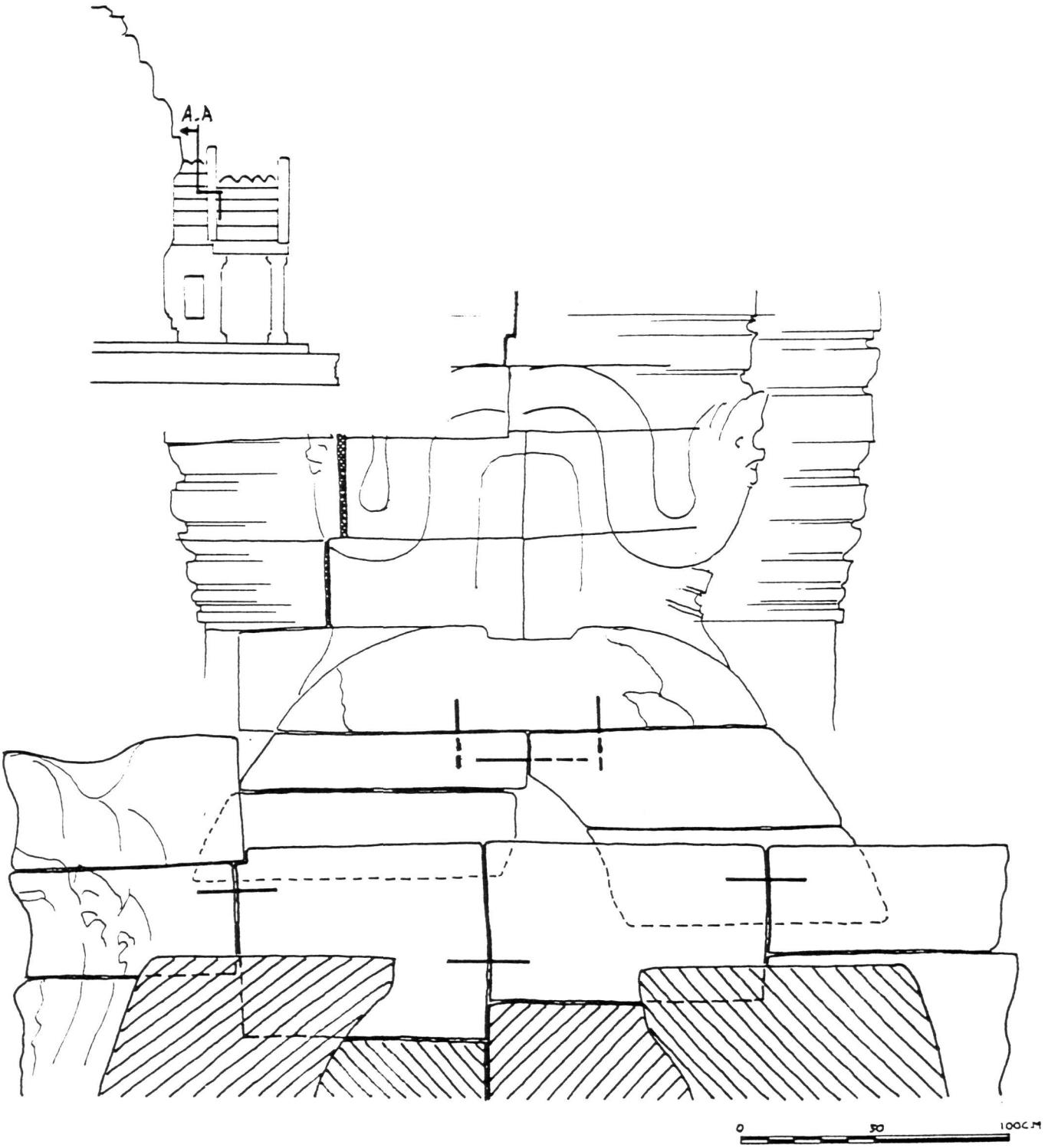
- *Unstable corbelled vaults* were systematically dismantled, columns reset, their capitals epoxy-injected, and broken stones were consolidated by means of the gluing and pinning techniques introduced by Mr. Pagnin; Morin, having trained with Pagnin, trained others on the stone conservation team in the epoxy stone repair techniques and mortar mixing;

- *Facial sandstone and laterite*: porosity tests were conducted, along with mortar mixing and matching exercises;

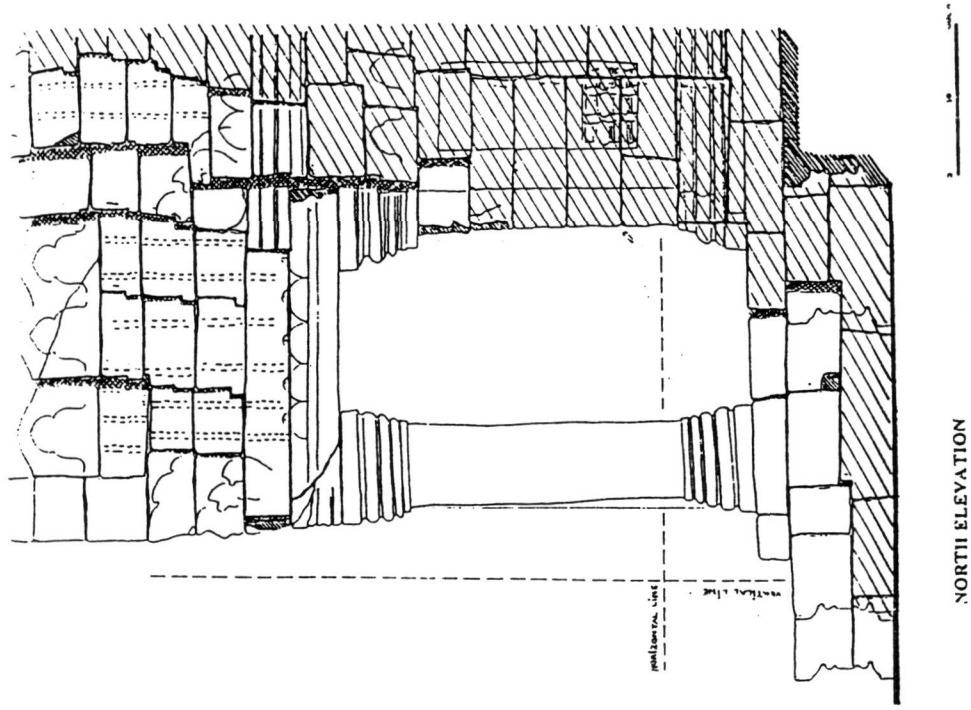
- *Northeast portico*, stabilization and repair of the decorated south lintel progressed with the successful consolidation of the lintel's shattered east bearing point; finishing touches put on the fractures on the northeast portico through epoxy resin injection, the pouring of molten lead into cracks and joints to prevent chipping; analysis of the distribution of dead and live loads showed that the team's initial fears of imminent structural failure were unfounded, making this project one of the most successful interventions at this location to date.

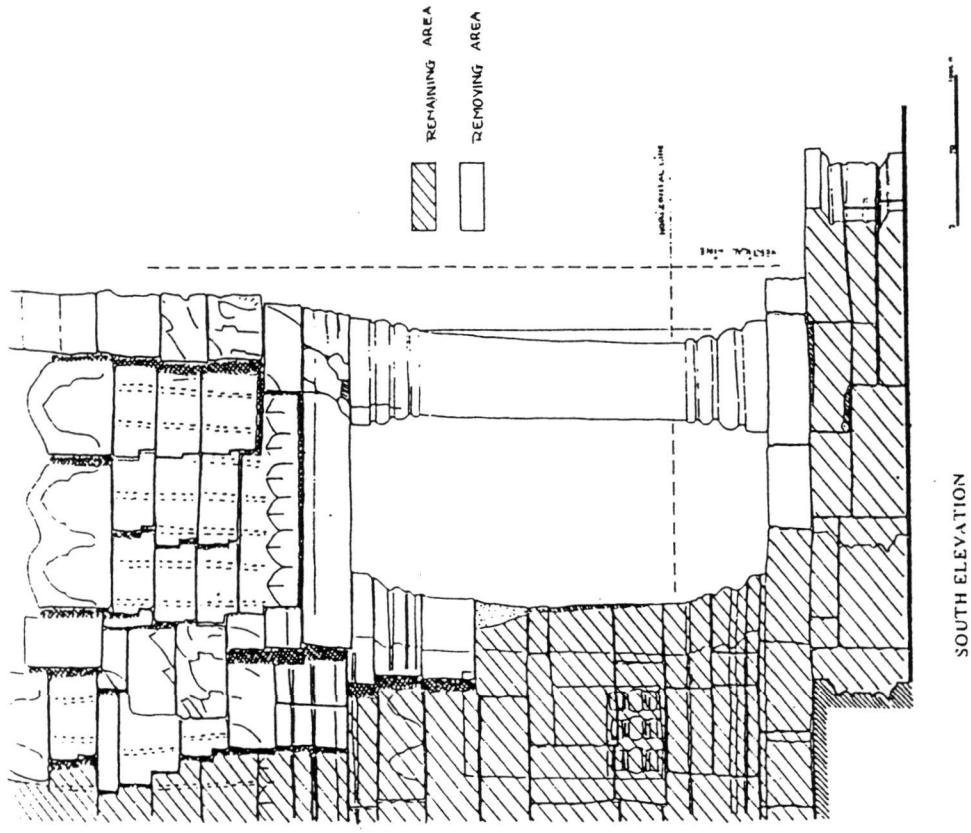


2.2.1a plan and section of east side of north portico

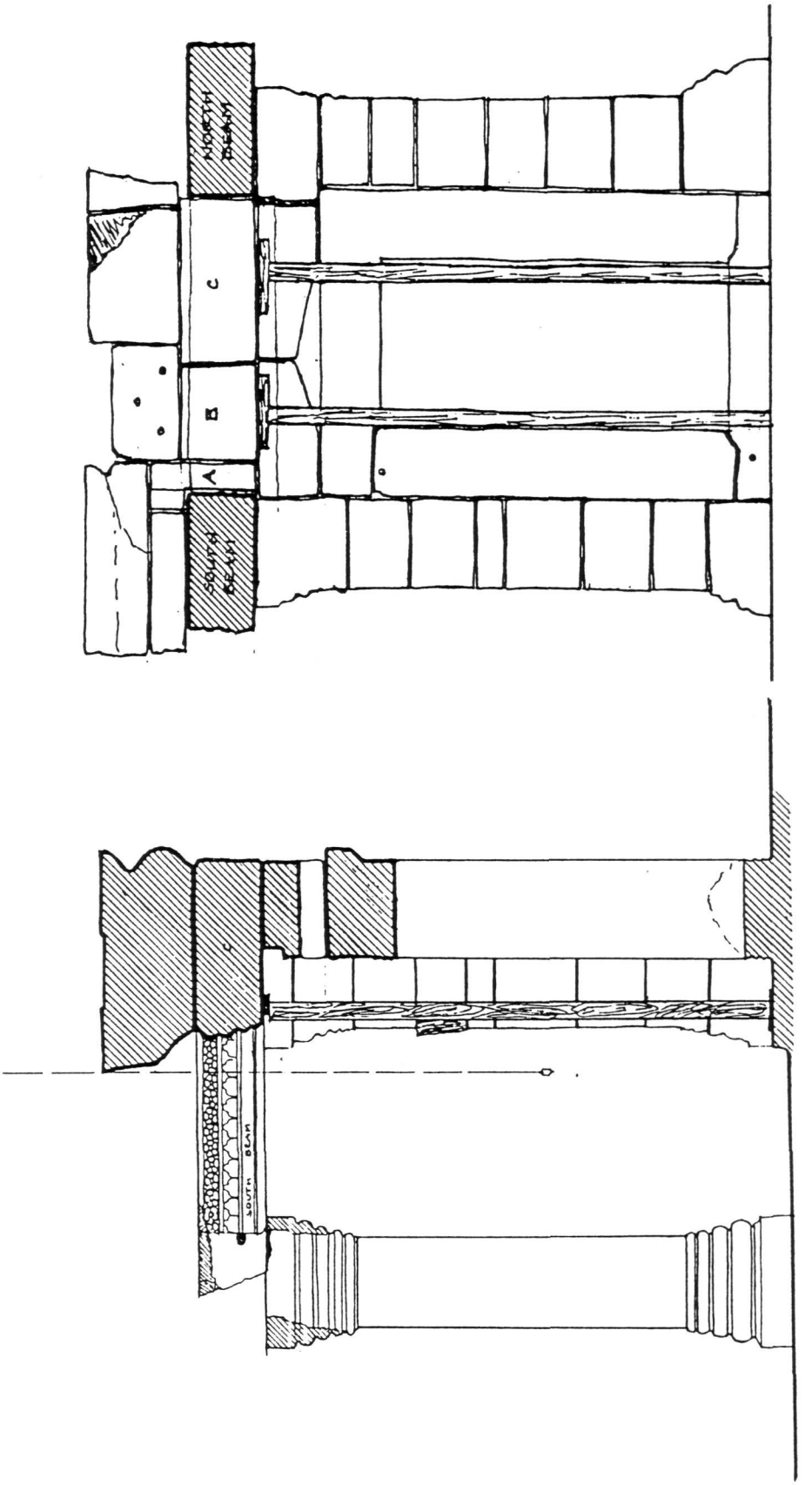


2.2.1b east side of north portico, wall section showing reinforcement

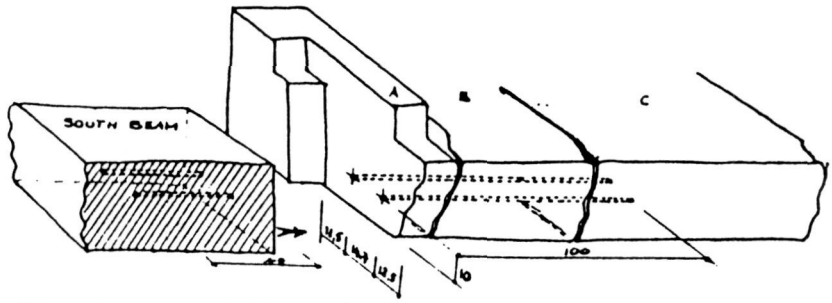




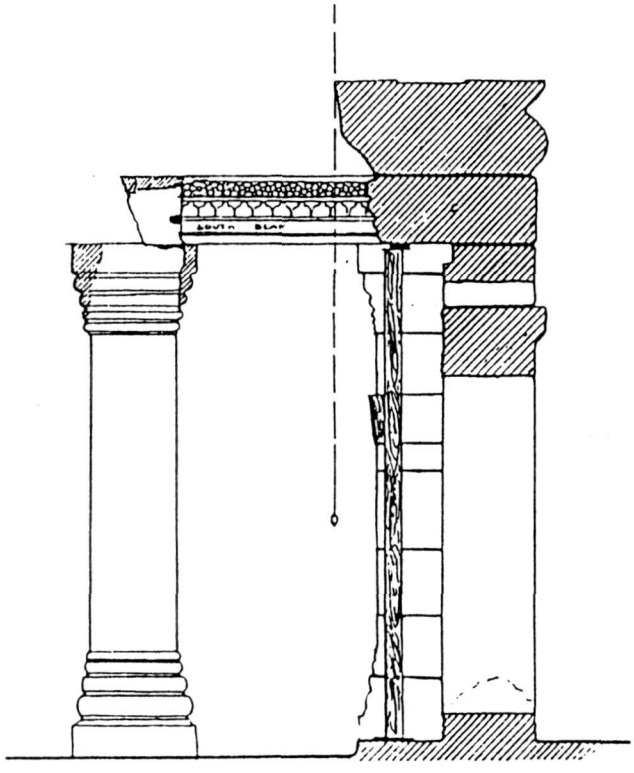
2.2.1c east side of north portico, south and north elevations



2.2.1d east side of north portico, south and north section and elevation showing repaired masonry



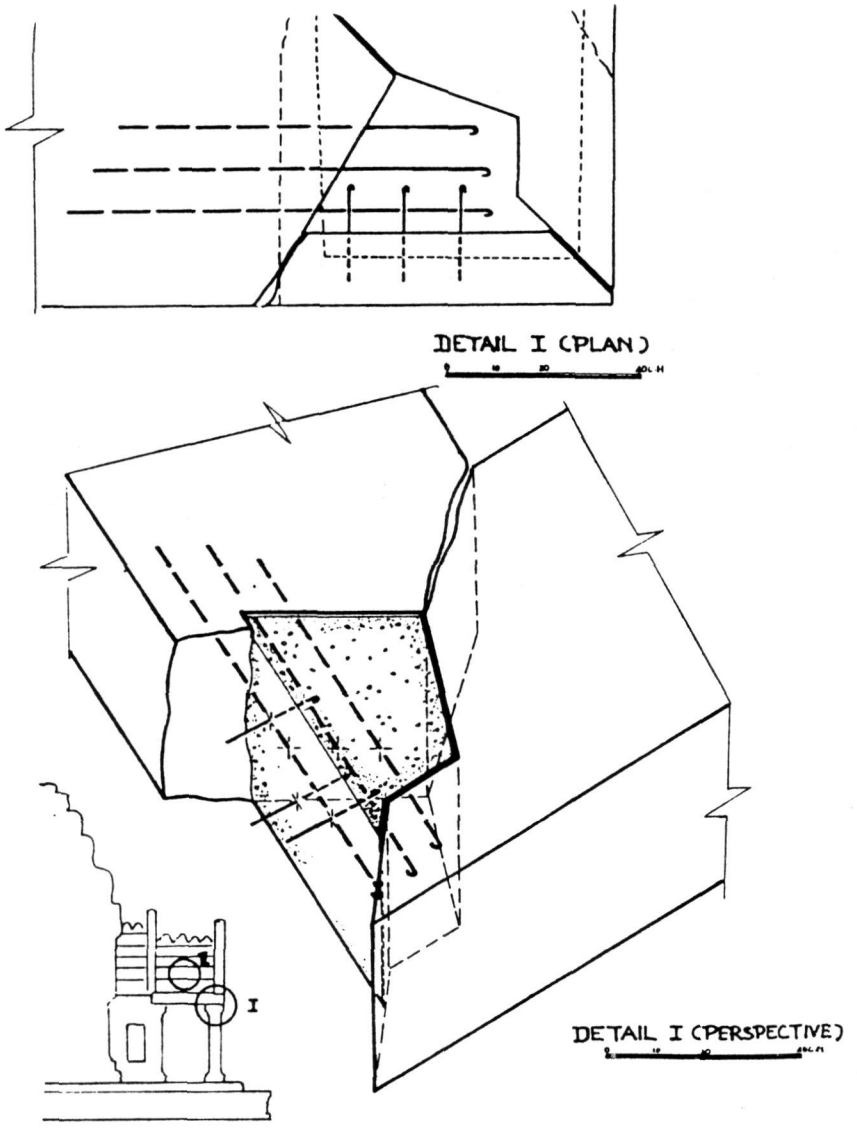
DETAIL SHOWING DRILLING
ON SOUTH SIDE



SECTION

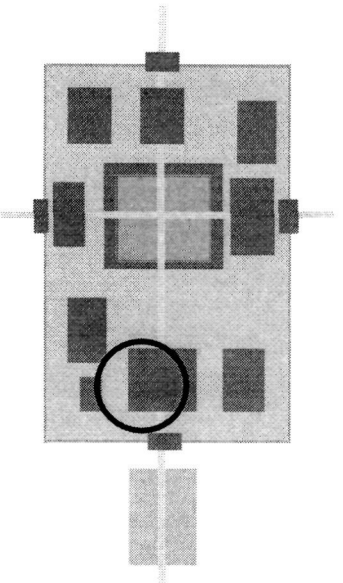
2.2.1e east side of north portico, masonry repair and reinforcement details

2.2.1f northeast portico tower before and after repair and consolidation



2.2.1g east side of north portico, perspective drawings of reinforcement details

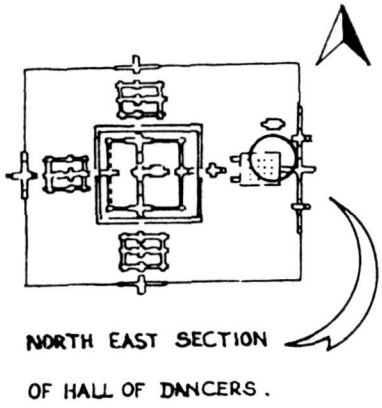
2.2.2 HALL OF DANCERS



The Hall of Dancers is located on the principal axis just inside East Gopura III. Work commenced during the 1994-95 season and is ongoing. The large cruciform vaulting system must have formed one of the most impressive interior spaces at Angkor; it is surrounded by a complex of courtyards enclosed by columns, lintels, and quarter-corbelled vaults. Much of the remaining structure is in a highly unstable condition. In the 1950s several interventions were executed to stabilize the broken or weak lintels with undergirding concrete beams; these were removed and structural members have been consolidated with stainless steel dowels secured with epoxy resin. *For previous studies and surveys, please refer to Preah Khan Report VI, section 5. Also see consultants' reports, summarized in this volume.*

Three separate projects were undertaken following additional survey work conducted during this campaign.

- *Southeast section of the East wall*: Detailed survey drawings were completed of the east wall of the Hall of Dancers section by Phally, Soma, and Heng prior to dismantling. The southeast wall was judged to be in danger of collapse, so preparation for structural consolidation was undertaken. In light of a a general policy to conserve rather than reconstruct the damaged structures, a strong scaffolding was erected to allow for on-site storage of unloaded, dismantled stone elements during the repair and resetting process. Survey drawings with numbered blocks of the central portico were completed under the supervision of Heng. Work also proceeded on the southeast wall's central section and plinth, distorted due to extreme leaning; these walls were pinned together near the top with stainless steel ties. These interventions have allowed the full-time stone conservation team to master the techniques of stone removal and storage which were introduced during the experts' missions.
- *Southeast sector vaults, lintels, etc.*: Repaired and consolidated using existing members with insertion of stainless steel dowels, conducted under the supervision of expert consultant Predrag Gavrilovic.
- *South Causeway outside the Hall of Dancers*: Along the south causeway, a central path was cleared of vegetation and all loose stones in the area were drawn and numbered. The paving in the northeast sector was also cleared and exposed; pillars and lintels of suspicious structural integrity were surveyed and considered for future intervention as part of field campaign V.

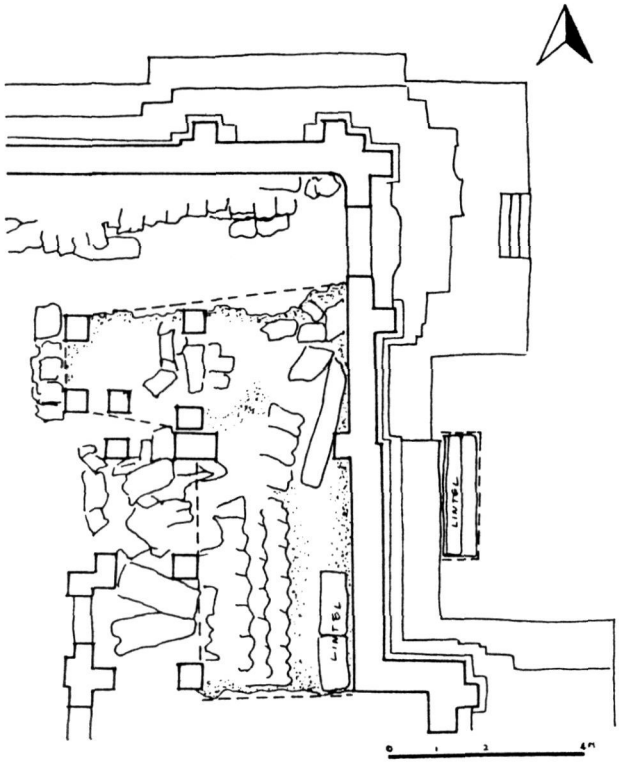


NORTH EAST SECTION

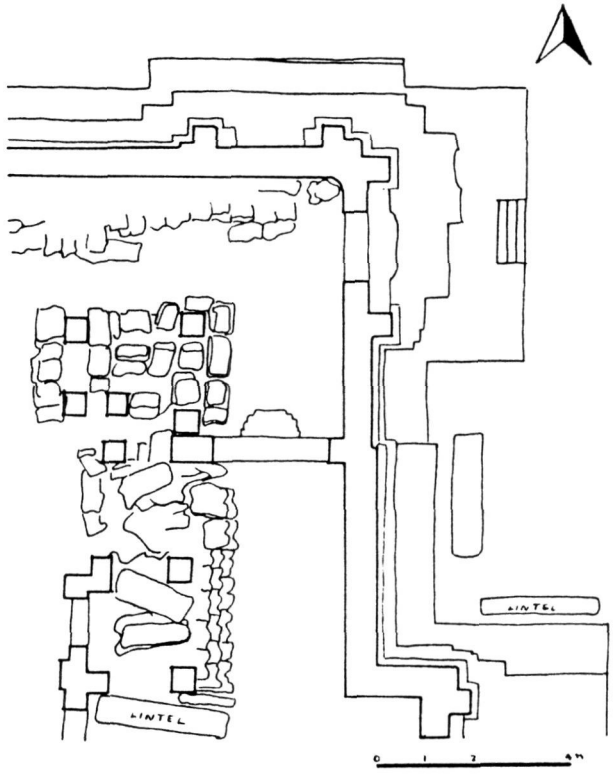
OF HALL OF DANCERS.

WORKING AREA

EARTH TO BE REMOVED

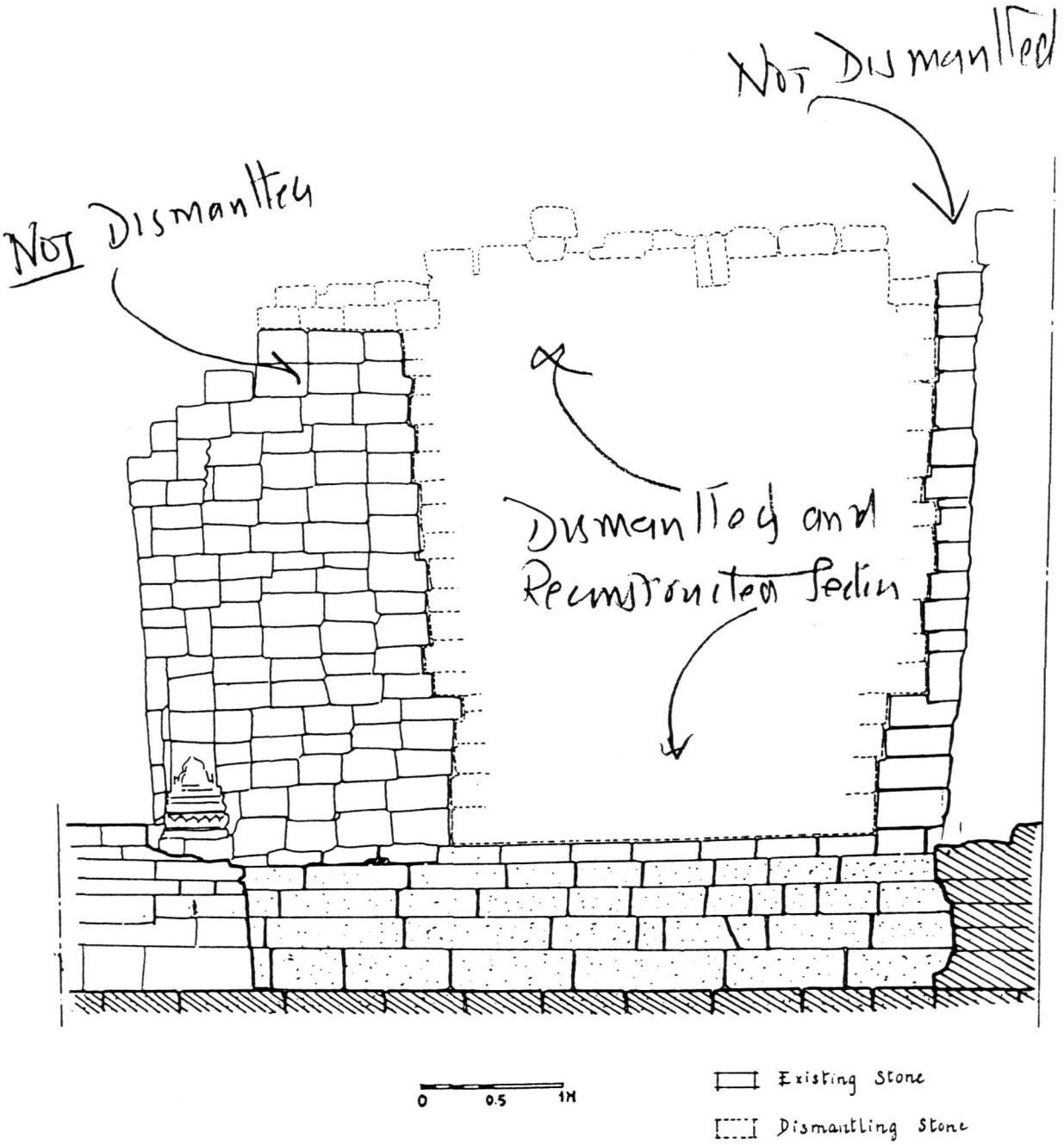


PLAN AS FOUND

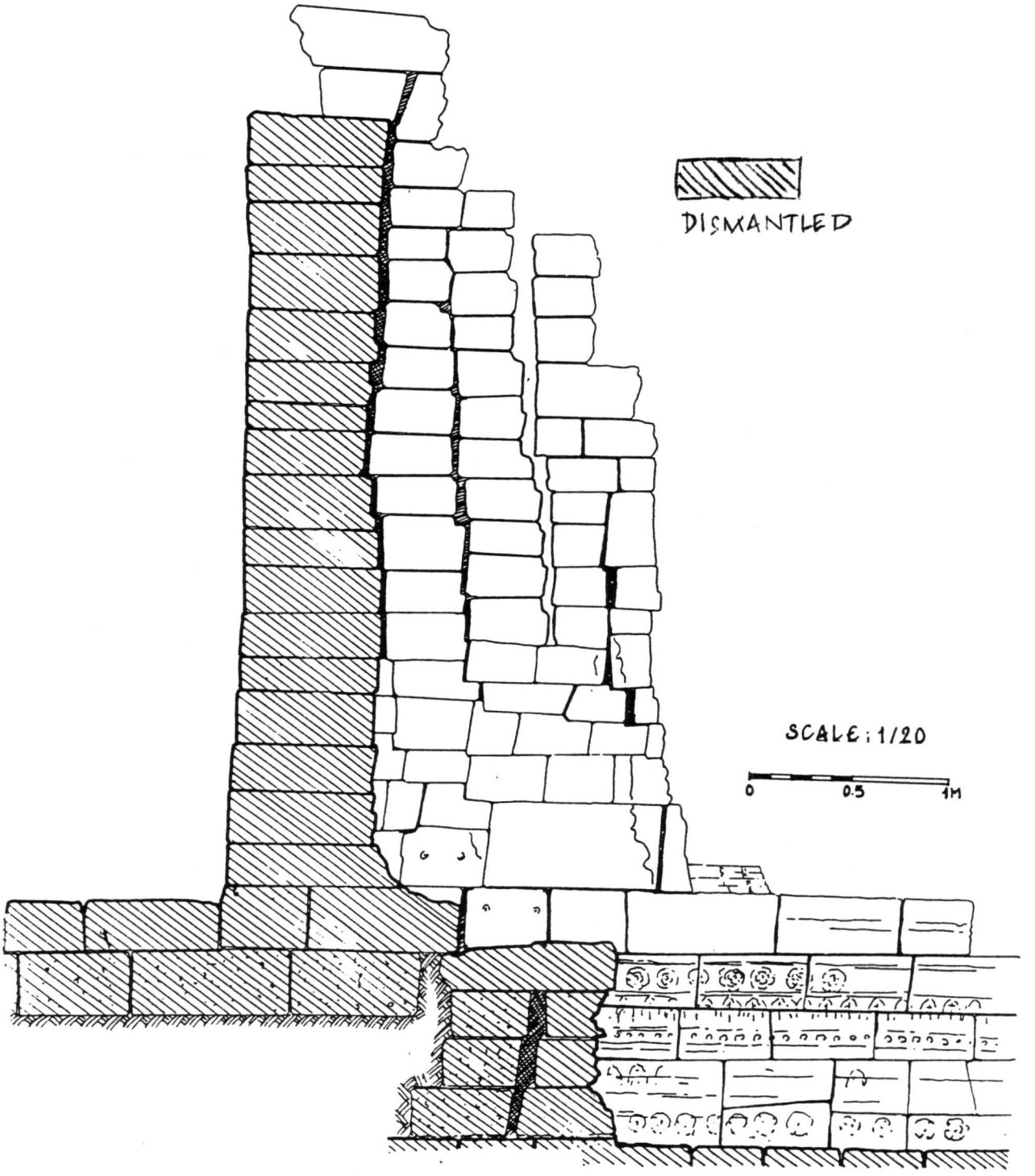


PLAN AFTER STONE AND EARTH REMOVAL

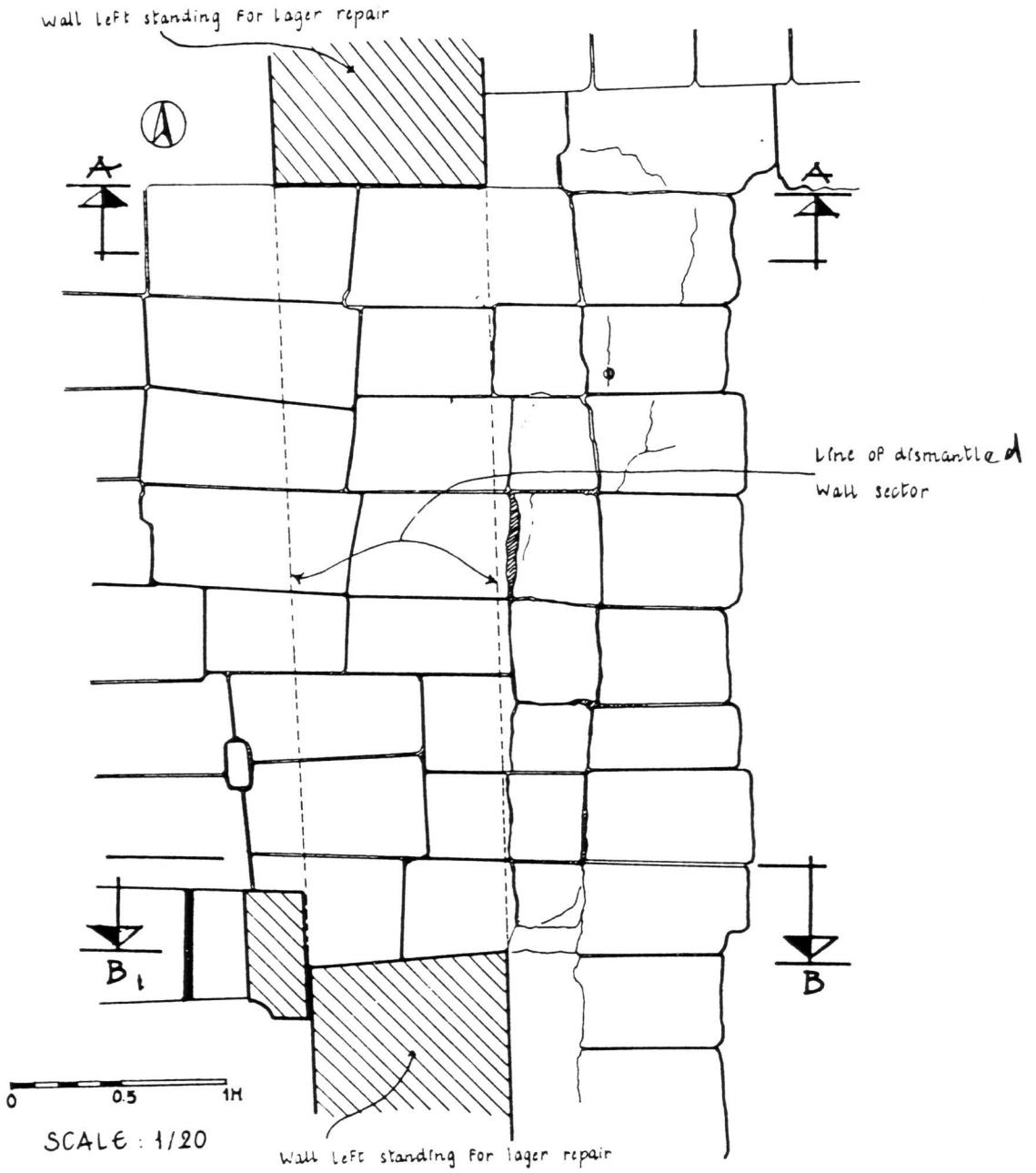
2.2.2a east entrance, plan before and after excavation of loose stone



2.2.2b east wall, southeast quadrant, dismantled and reconstructed areas

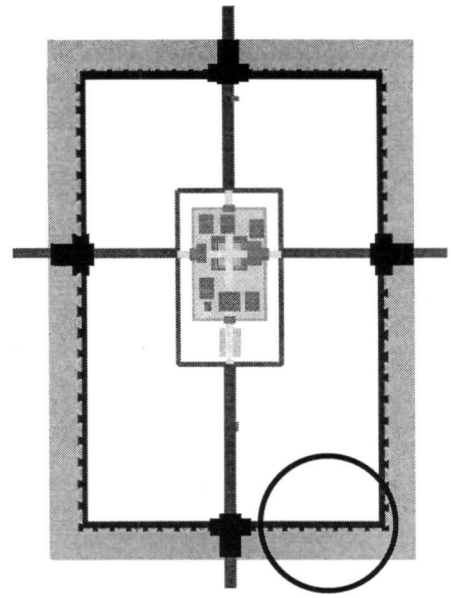


2.2.2c southeast quadrant, section of dismantled and reconstructed wall



2.2.2d southeast quadrant, section of dismantled and reconstructed wall, working drawing

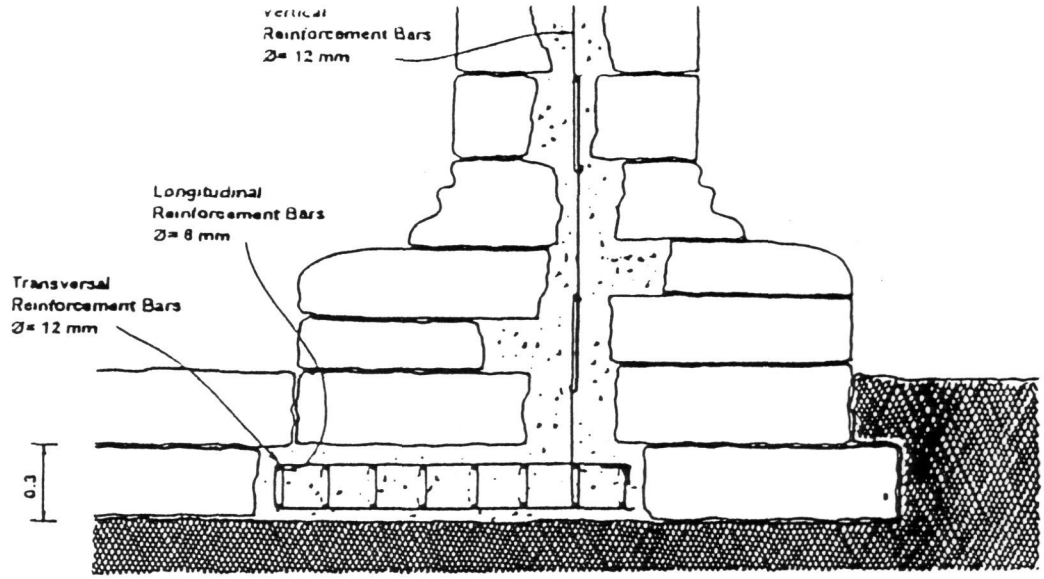
2.2.3 ENCLOSURE WALL IV



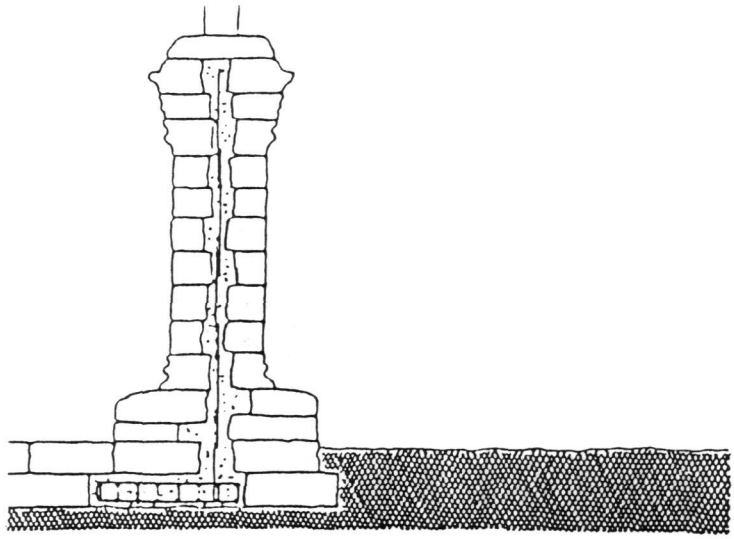
Enclosure Wall IV and the moat form a rectilinear boundary enclosing the Preah Khan temple complex. The total wall length is approximately 2,760 meters and the precinct contained within it measures 950 by 750 meters. The laterite used in the construction of Preah Khan's outermost protective enclosure is thought to have been excavated from the moat. Were the wall to be completely restored, normal access to the temple could be controlled through the four principle entrance gopuras. *For previous studies and surveys, please refer to Preah Khan Report VI, section 6 and Appendix A and Report V, section 3.*

About 15 meters to the North of East Gopura IV, a 20 meter wall section standing approximately 4 metres high had collapsed outward at an unknown time, probably within the past one hundred years. The cause of this degradation seemed to be substrate slippage and the hostile encroachment of tree roots. During Campaign IV the stone repair team undertook the repair of this section, built of laterite blocks laid on a stepped laterite foundation measuring approximately 1.25 meters in depth. Studies determined that it would be necessary to lay a new foundation underneath the collapsed wall, and plans for this intervention were finalized by structural engineering consultant Predrag Gavrilovic in October 1995. In January, dismantling of defective sections began and was followed by excavation of defective laterite blocks below grade in preparation for pouring of a reinforced concrete foundation. Drawings were prepared by the Preah Khan team and approved by Gavrilovic prior to the beginning of work.

In January the dismantling of defective sections was completed, along with the excavation of faulty laterite blocks in the foundations in preparation for a new reinforced concrete foundation. The plinth—where the hollow gaps were originally filled with rammed earth and sand—was found to be infested with termite nests and hollows which may have contributed to the weakening of the wall. In resetting the wall to a plumb vertical condition, many of the original facing laterite blocks were split and reused, and the internal gaps were filled with a new mixture of large laterite aggregate in a weak concrete slurry. The placement of steel reinforcement mesh into this infill slurry was recommended by consultant Gavrilovic. Special attention was paid to the wall sections anchoring garuda statutes along the length of the wall.

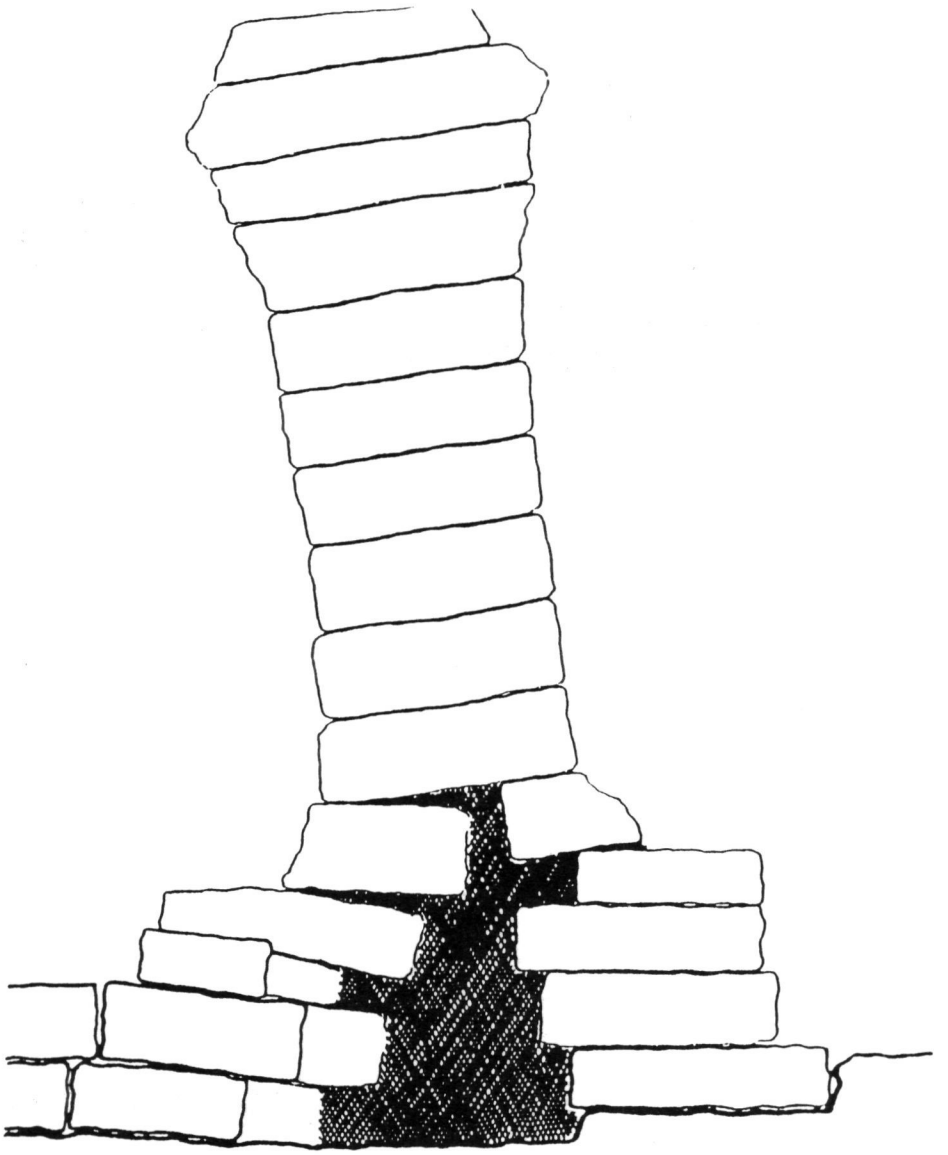


Detail Scale: 1/20

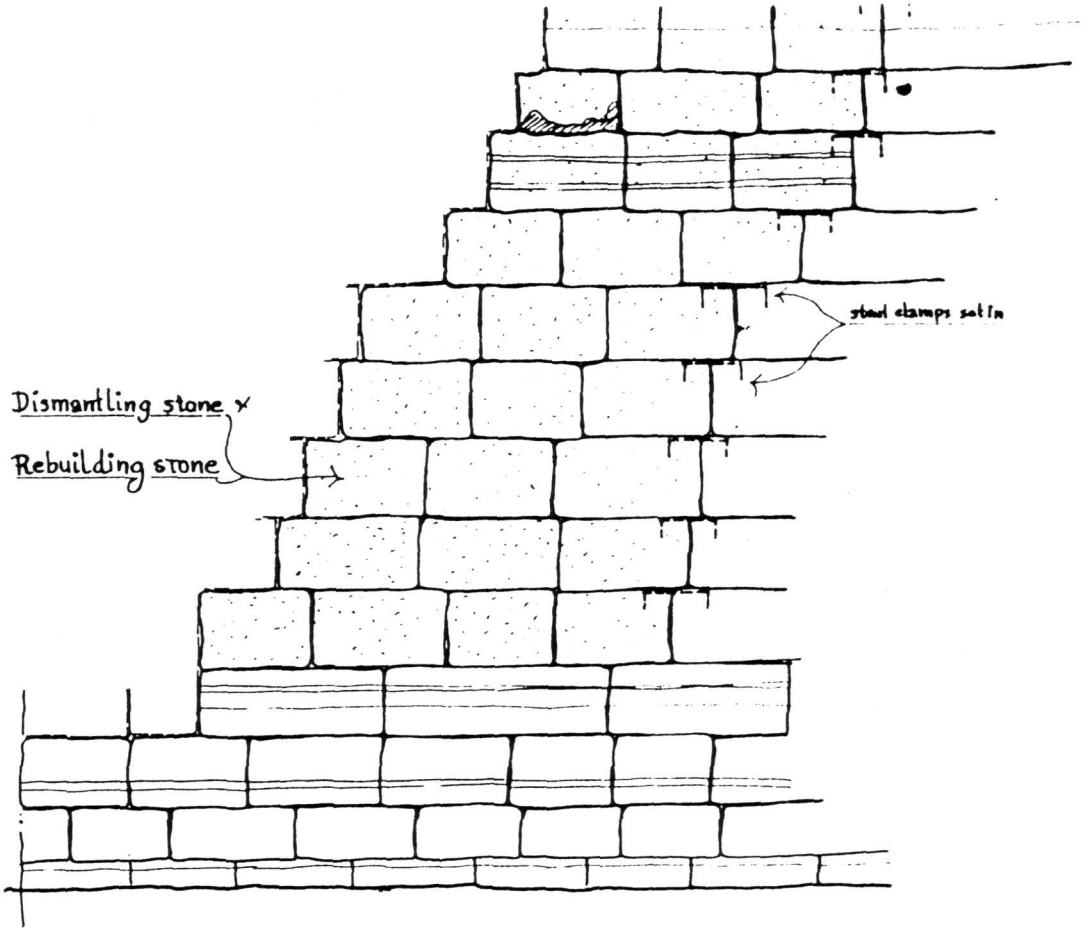


Section Scale: 1/50

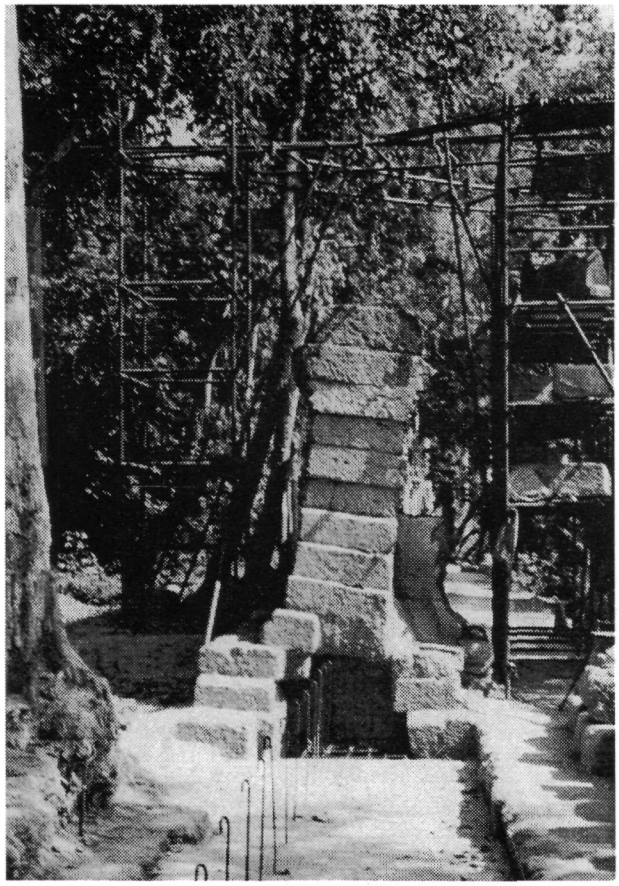
2.2.3a northeast section, proposed reapair and reinforcement

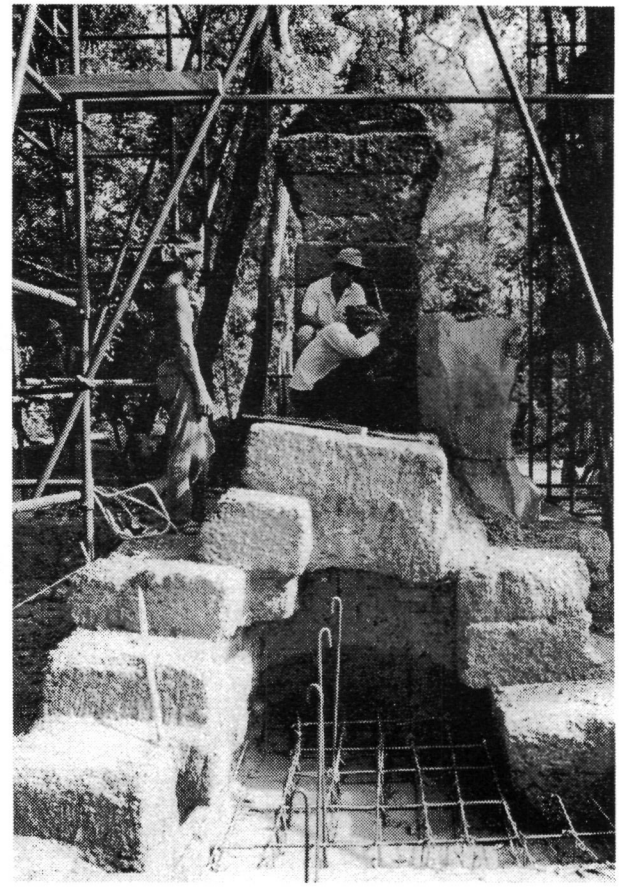


2.2.3b northeast section, existing conditions

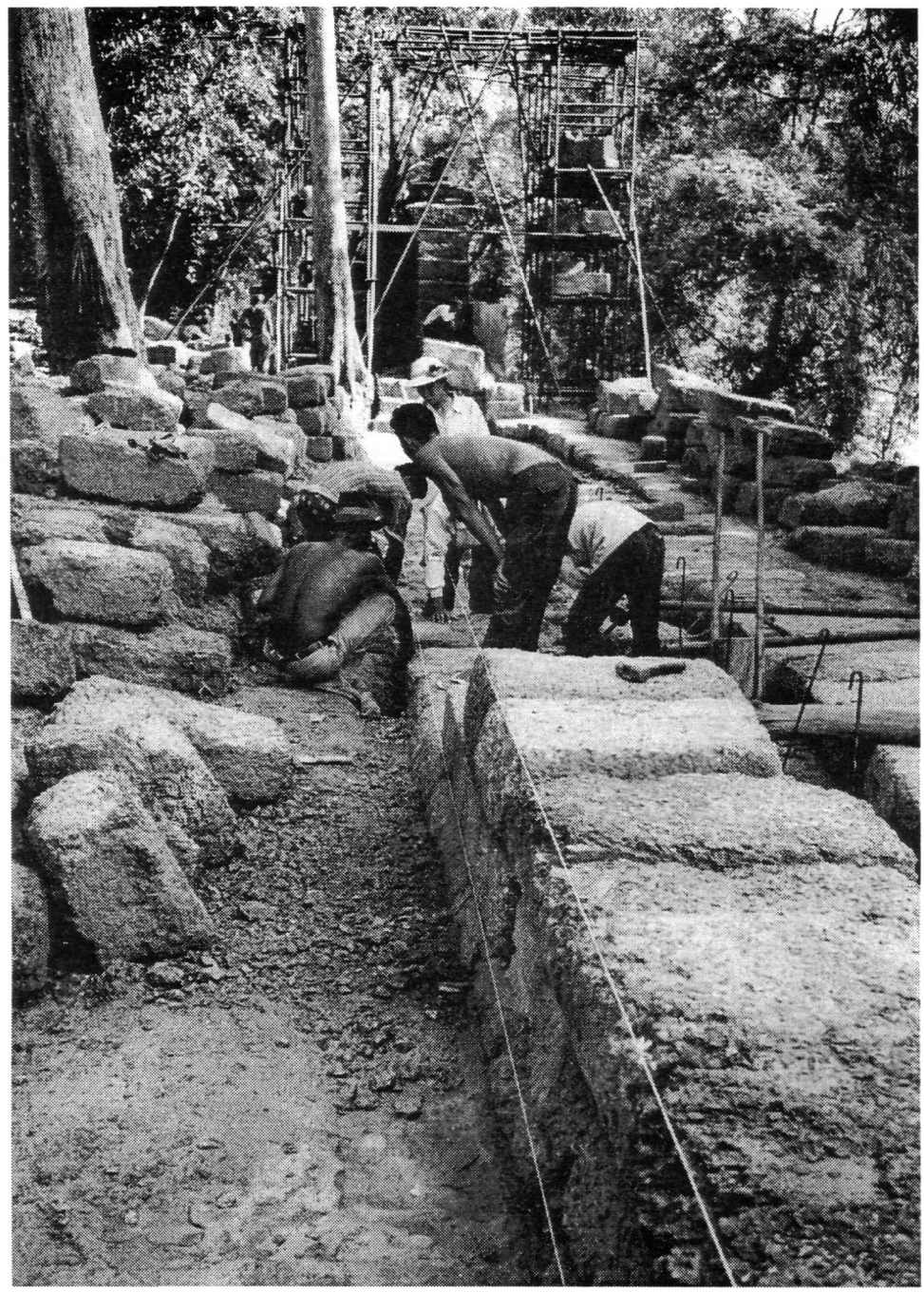


2.2.3c northeast section, proposal for masonry linkage of reconstructed sections with steel clamps



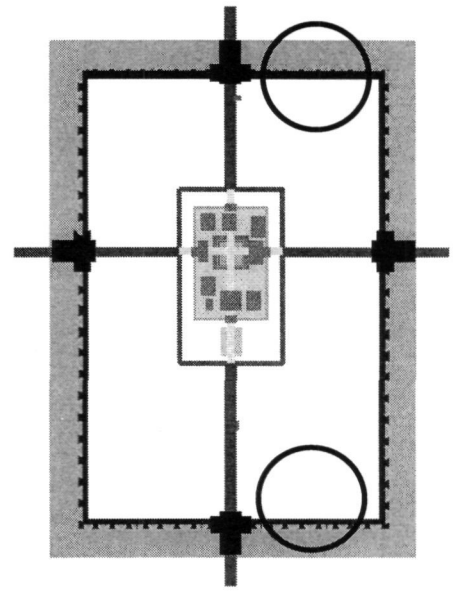


2.2.3d foundation replacement work underway



2.2.3e foundation replacement work underway

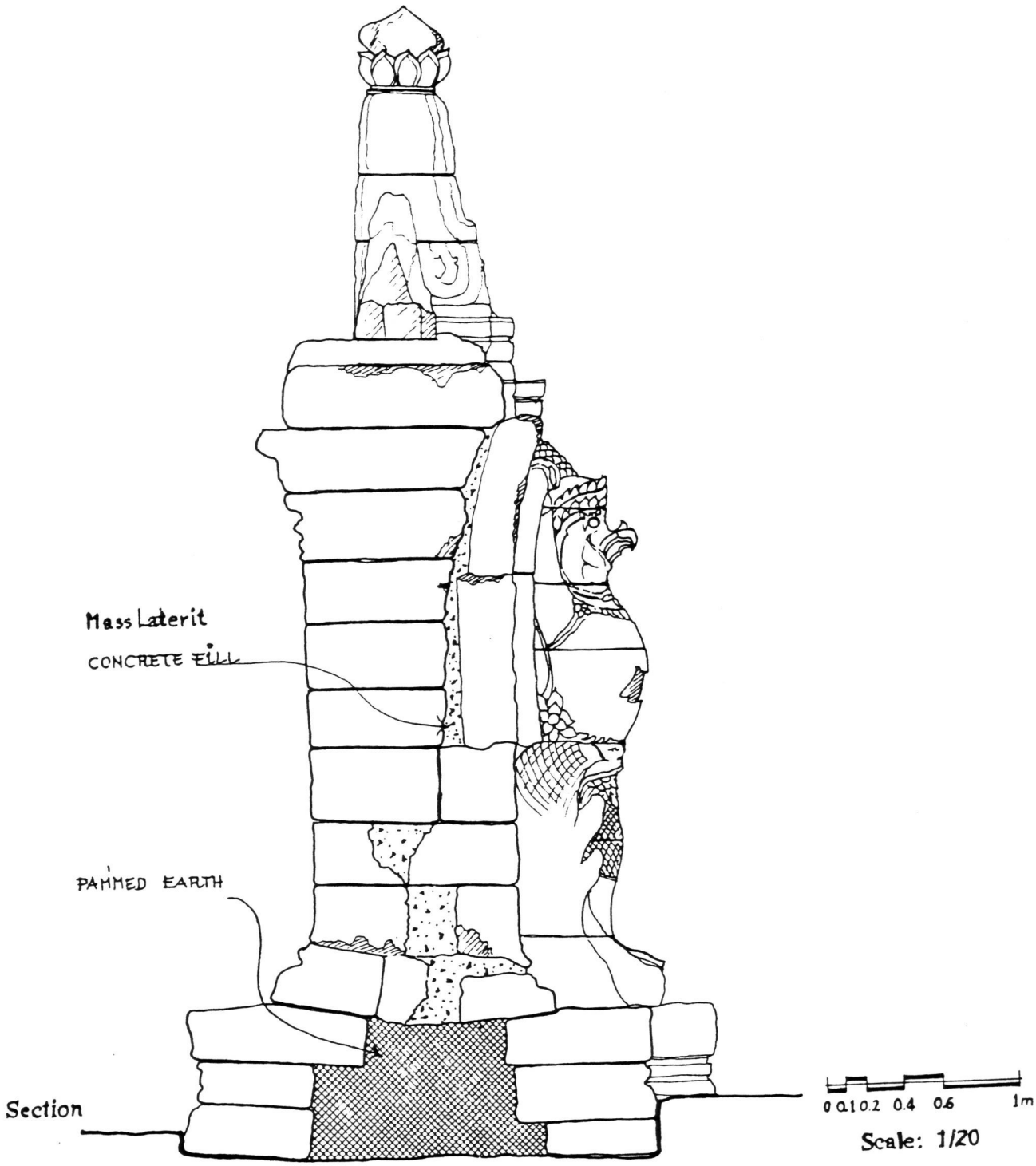
2.2.4 GARUDAS



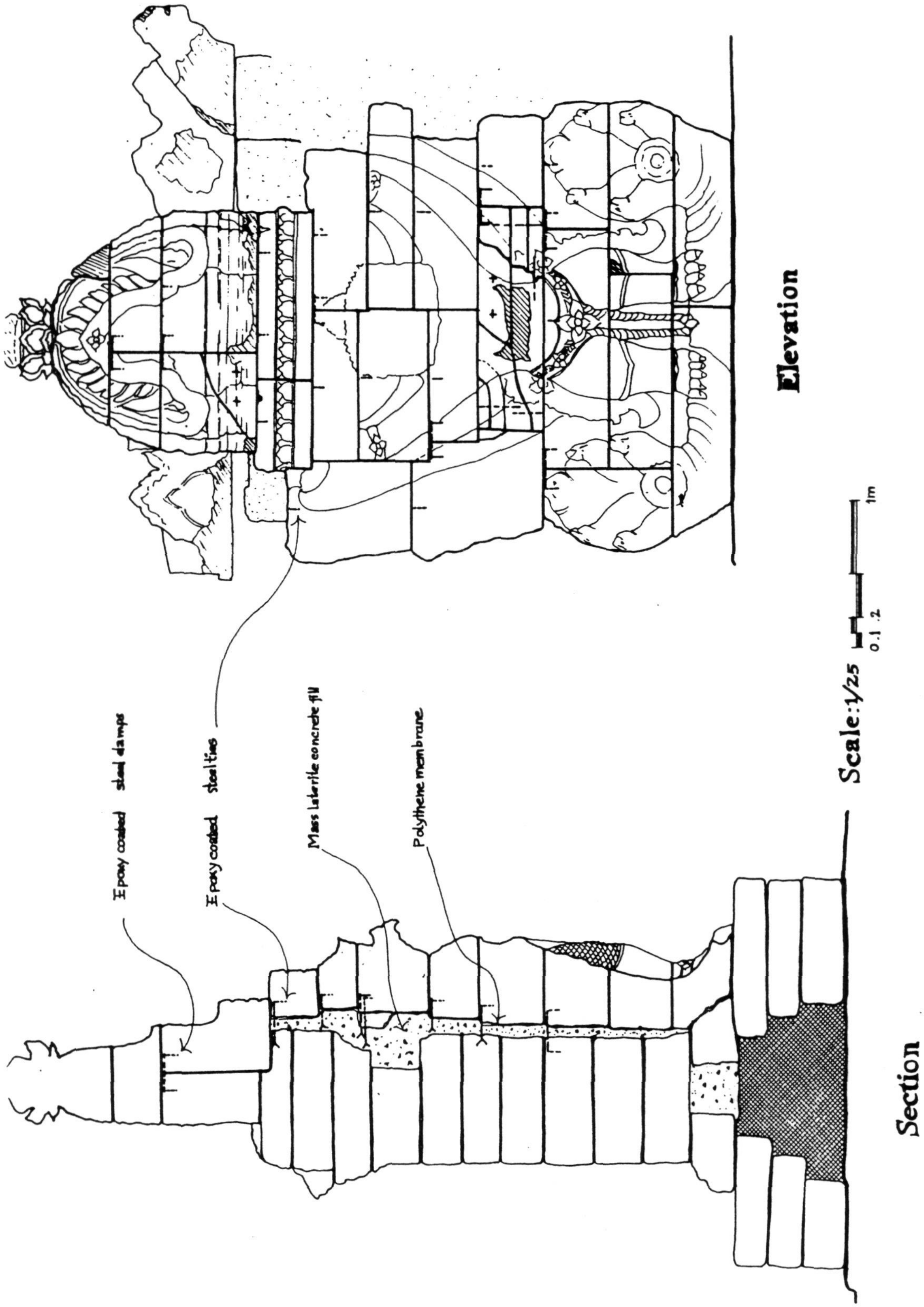
Seventy-two monumental sandstone engaged *garuda* statues are spaced every 35 meters along the outward face of enclosure wall IV, and they stand the full height of the wall (3.25 meters) with minimal connection to it. A fund-raising and conservation strategy called "Apopt a Garuda" has been developed, in which donors are solicited for contributions of $20,000 to support the Preah Khan Conversation Project and provide for the consolidation and repair of a single statue. Proper repair involves survey, dismantling, removal of termite mounds, realignment, resetting and pinning to laterite backing wall. *For previous studies and surveys, please refer to Preah Khan Report VI, section 3.*

Following the successful repair of the "Rosetta" garuda in December—the first of the 72 targeted sculptures to be adopted by Sam and Rosetta Miller—work commenced on the next garuda, NE35, which has been adopted by Christopher Brewer. Work followed the patterned established with the "Rosetta": study, survey, dismantling, repair, recutting, resetting, and pointing. During this process, it was noted that additional laterite (backing) consolidation was needed; accordingly, damaged stones were lifted from their beds for repair. This sandstone and laterite, typical for most buildings in the Preah Khan complex, is fragile and spalling; all fragments were saved and consolidated with epoxy glue. The damaged plinth was repaired with insertion of stainless steel ties and clamps.

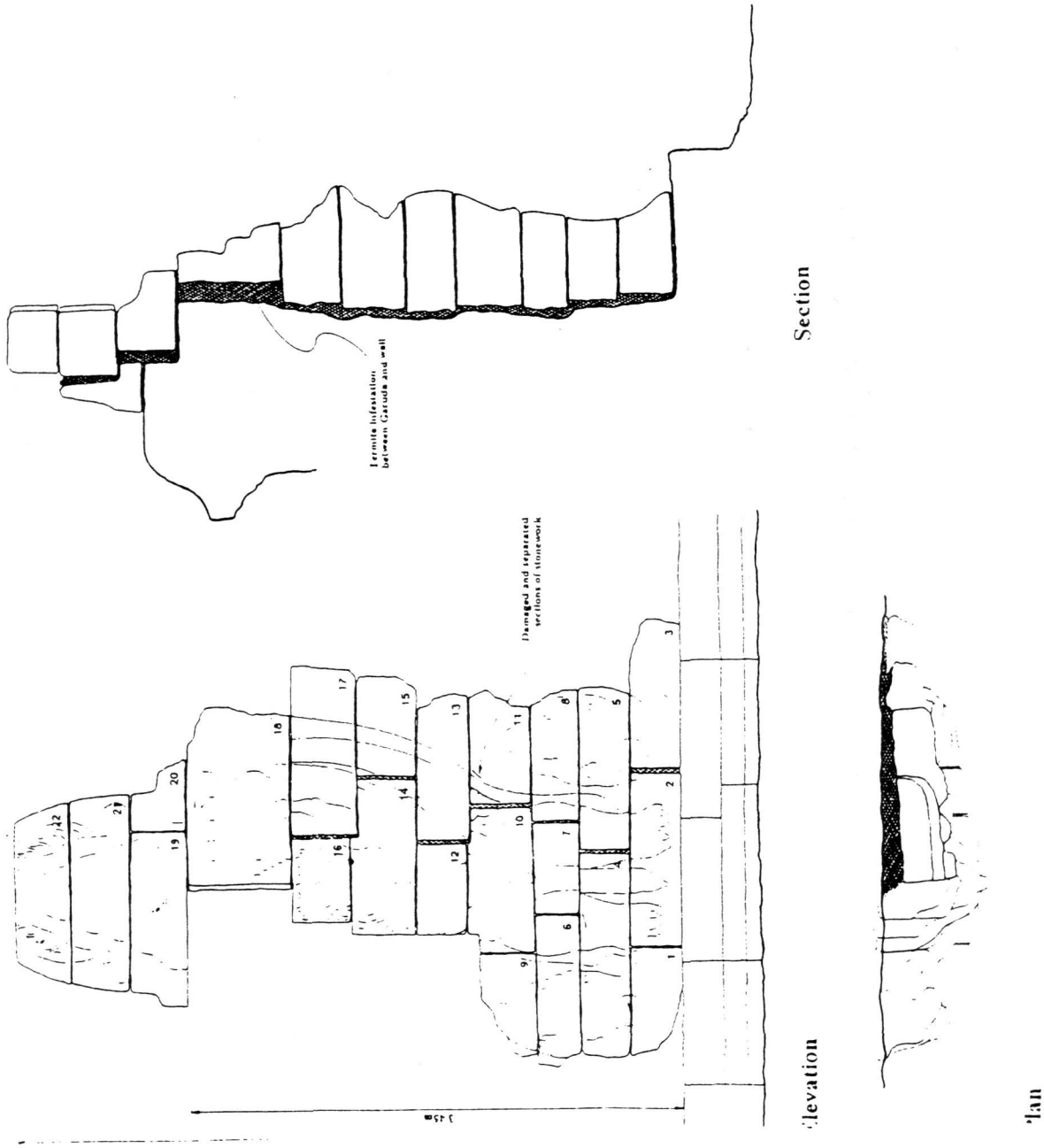
NE31 garuda is the next to be undertaken after the "Brewer" (NE35); it is collapsed and survey drawings have already been prepared and a scaffolding erected.



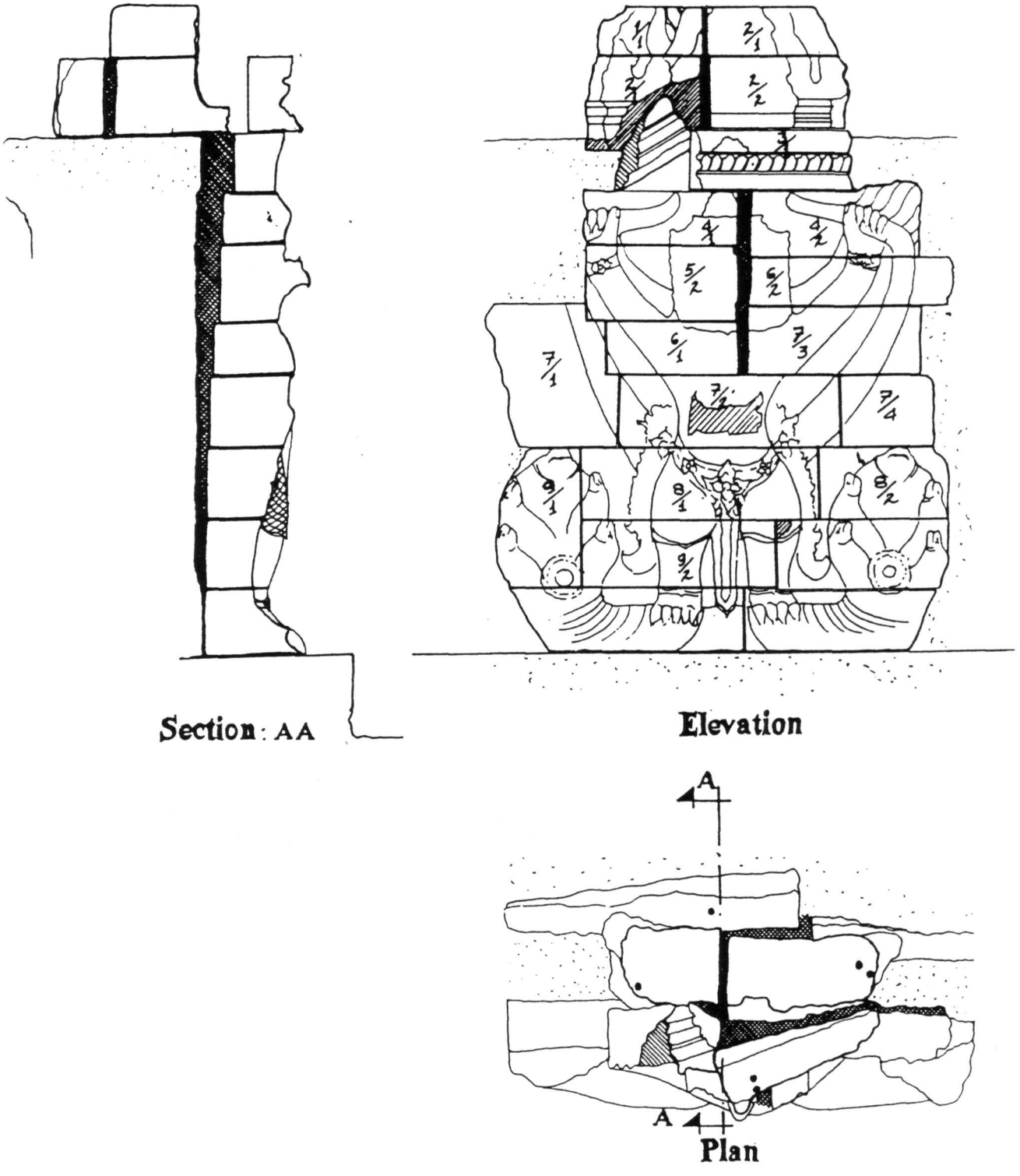
2.2.4a Garuda NE35, profile view after infill and restoration



2.2.4b Garuda NE35, section and elevation showing repairs and clamps

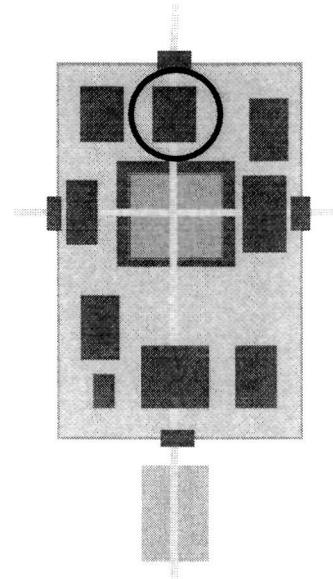


2.2.4c Garuda NW1, survey and numbering drawing showing termite infestations



2.2.4d Garuda NE35, survey and numbering

2.2.5 CENTRAL BUDDHIST COMPLEX: SOUTHWEST COURTYARD

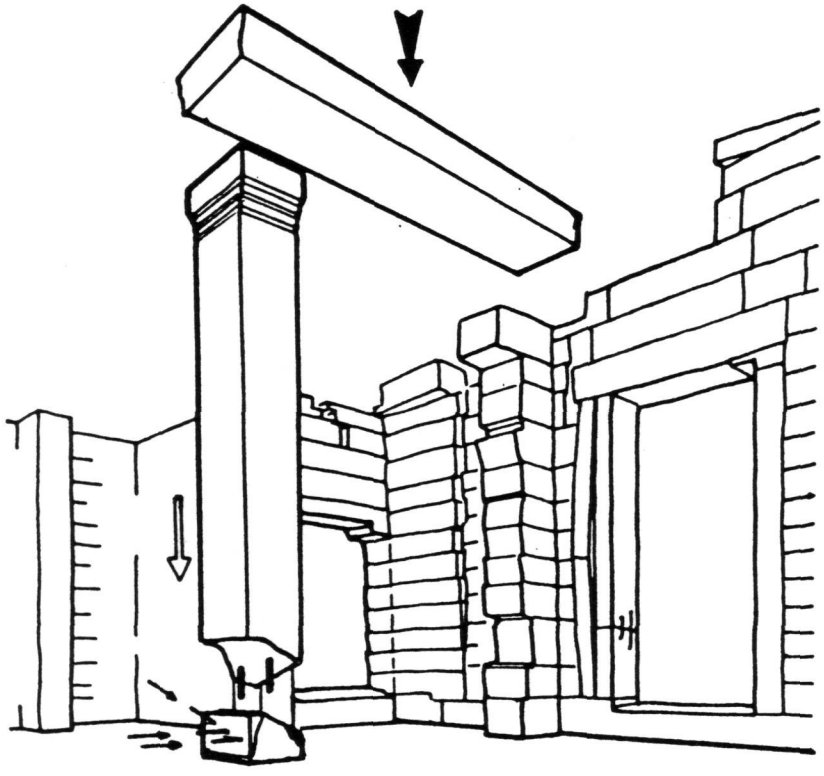


Preah Khan's second enclosure wall surrounds the principal religious compound; it comprises a dense concentration of temples and shrines consecrated to the Hindu sects of Vishnu (North) and Shiva (West); the central shrines are Buddhist and the southern quadrants are dedicated to the worship of the late kings. *For previous studies and surveys, please refer to Preah Khan Report IV (project 5 and appendix C), separate Report IV appendix B, and Report III, page 80ff.*

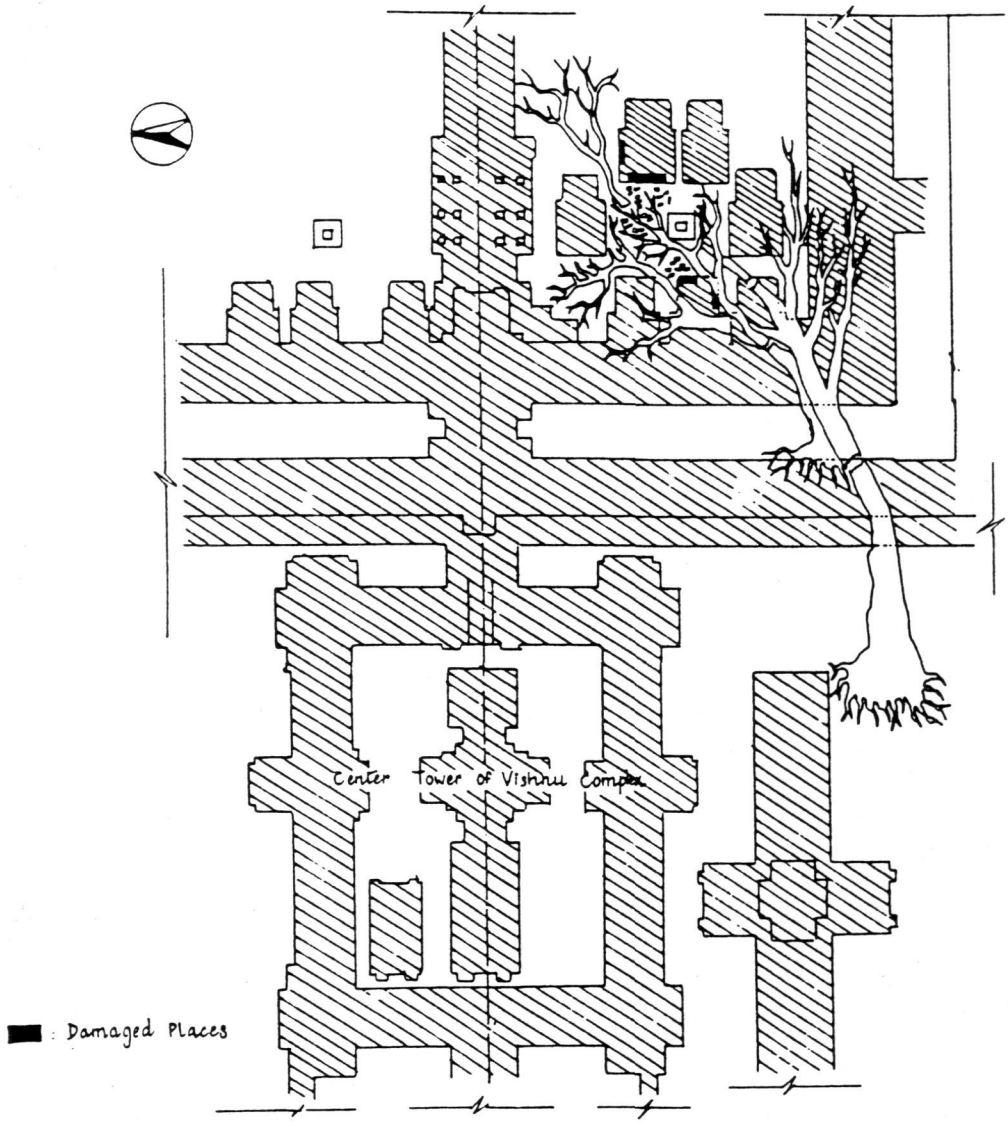
On 8 June 1996 two large trees fell into the southwest courtyard of the central Buddhist complex causing a certain amount of damage to several of the individual shrines. An emergency work force was immediately set to work to clear the trees and to assess the damage. Following this assessment, it is proposed to reinstate the dislodged stones, to repair the damaged decorative stones and to stabilize the sections which were damaged. *For previous studies and surveys, please refer to Preah Khan Report VI, appendix C and Report V section 4 entitled "plant control".*

Following a small amount of rain, a large "Fromagere" tree (*tetrameles nudiflora*) uprooted itself and fell across the South West sector of Enclosure Wall I and Enclosure Wall II. It fell in a north-easterly direction hitting a second large tree that was growing around the vaulted roof structure of Enclosure Wall II. Both trees fell onto the vault of Enclosure Wall I, causing minimal damage; two large holes were punched through the vault but the section onto which the tree trunks fell did not collapse. The branches of both trees caused some superficial damage to two large free standing shrines and to two of the smaller shrines attached to the South West sector of Enclosure Wall I. Fortunately, the upper section of the tree fell between the two free standing shrines.

The trees have been carefully disentangled from the structures and removed. Detailed surveys have been undertaken to record the structures as they stand, to identify the dislodged stones and to plan for any structural interventions. All the broken pieces of stone have been collected and, where possible, pieced together and glued. A full structural assessment was undertaken in November to ascertain the extent of damage and a detailed work program has been implemented. The three damaged shrines and vaulted passages have been reconstructed following instructions provided by the consultants.

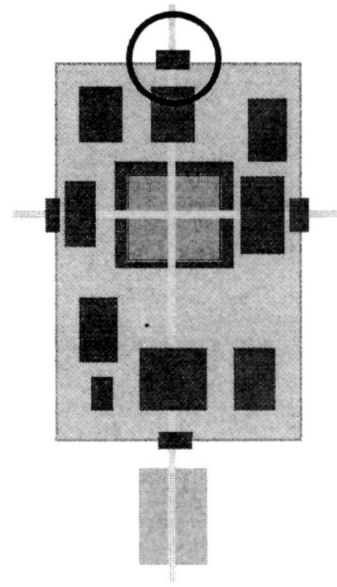


2.2.5a broken column at east corner of the central tower, scheme for consolidation



2.2.5b location of fallen trees in southwest quadrant

2.2.6 WEST GOPURA III: DVARAPALA FREESTANDING SCULPTURE

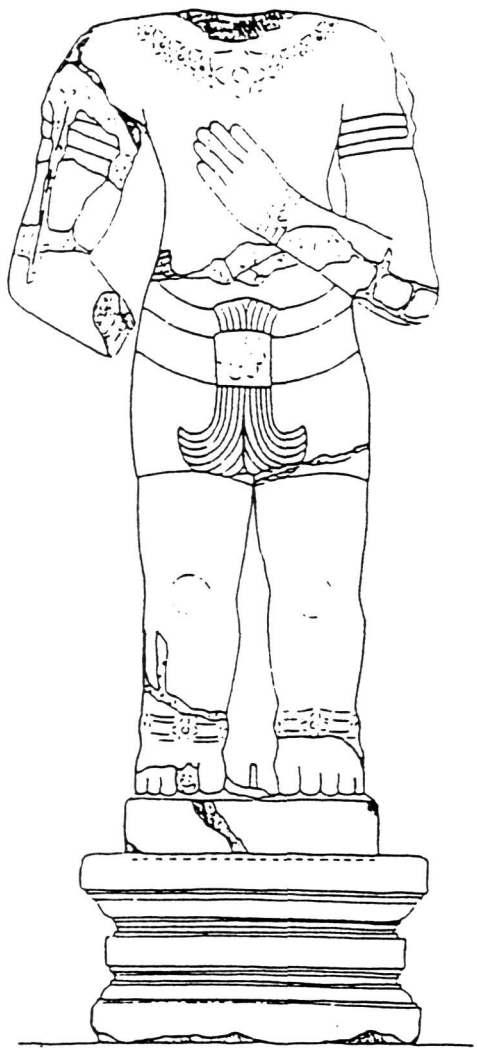


The "Dvarapala" sculpture is the southernmost of a pair of twin guardian statues that originally stood sentinel at the West Entrance to West Gopura III. *This project for emergency consolidation was identified as part of Preah Khan campaign III and specified in Report six; please also refer to section 2.3.1 of this report and separate Appendix A, section 4.*

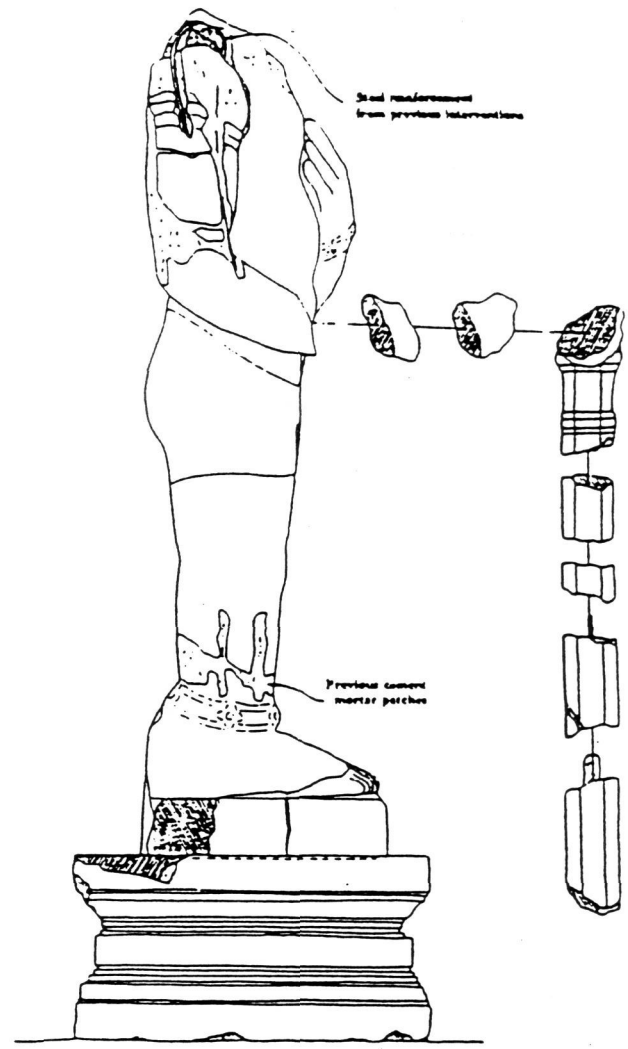
The Dvarapala is a headless monolithic sculpture; the guardian's club and the lower sections of both left and right arms are also missing. The sculpture was previously repaired by the EFEO using reinforcing steel bars as armatures to refix broken sections, which were placed in grooves cut into the stones and later covered with a cement sand mortar. Since this intervention, several sectionsÑincluding the club and lower sections of the arms—have become detached again; most of the missing sections have been found buried close-by.

At the beginning of this year, a program for sculpture repair and conservation was initiated on the southern Dvarapala, where special techniques and mortar mixes were developed to demonstrate techniques appropriate to this kind of repair. Conservation procedures were tested and implemented by Paolo Pagnin, the stone conservator acting as special consultant to the Preah Khan team.

The process of repair is highly complex, but the techniques for repair are clearly understood by a specially trained team and supervisor. The armatures used to piece the fractured stones together are fiberglass dowels of various sections and lengths, and the fill consists of a bonding compound composed of resins, stone dust and natural coloring. The compound was brought to within a centimeter of the outer edge of the sculpture. Many sample mixes were prepared, dried, and tested before determining a final formula, and test areas are visible on site.

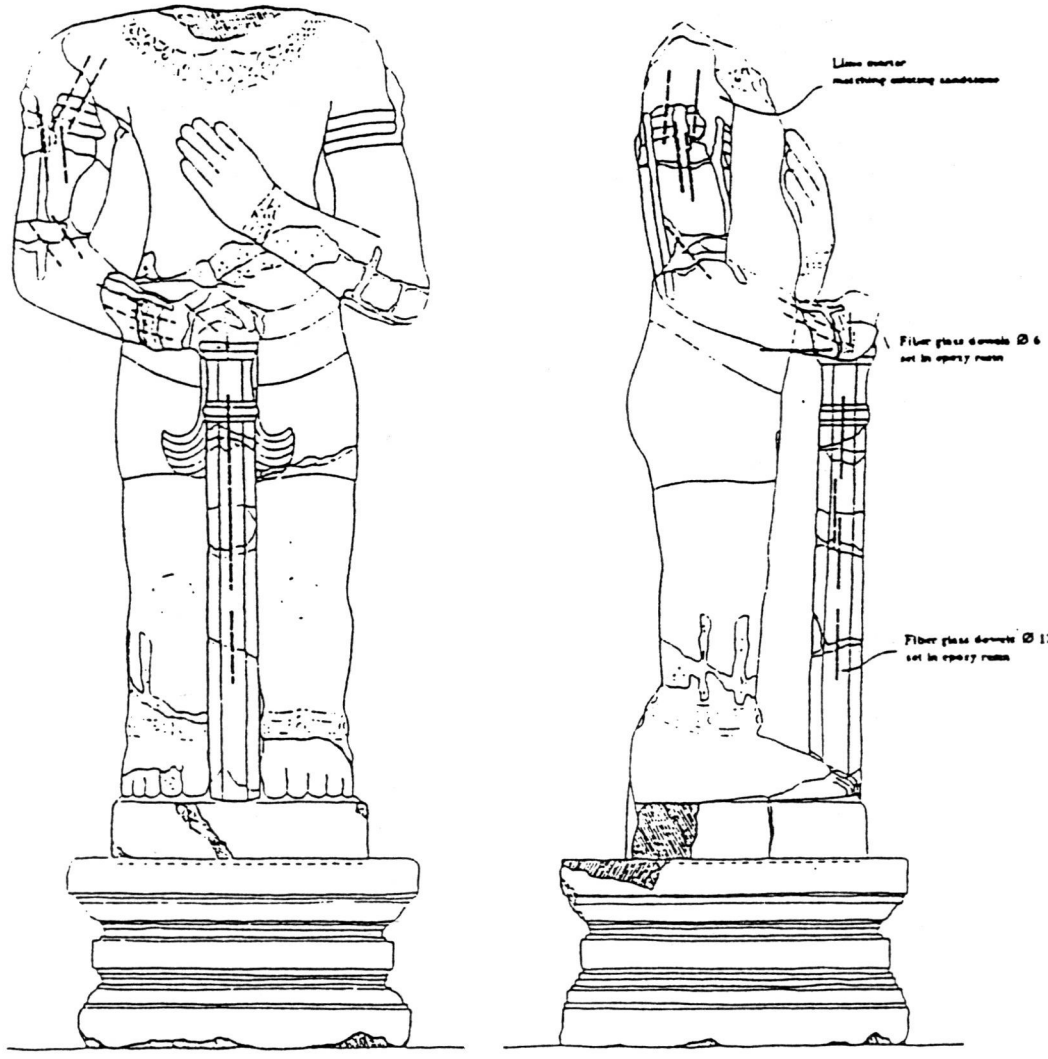


Front view



Side view

2.2.6a south Dvarapala, as found condition

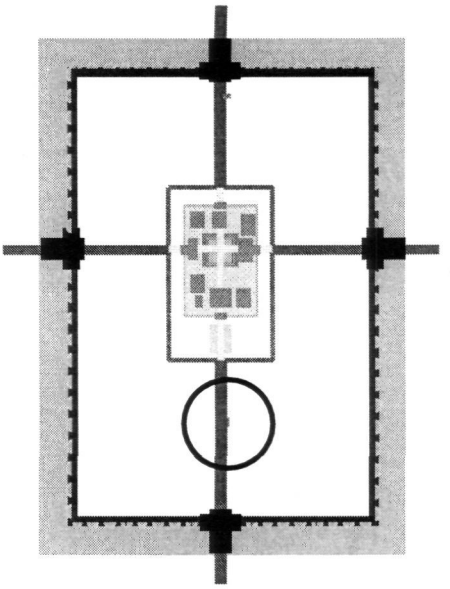


Front view

Side view

2.2.6b south Dvarapala, repair and strengthening

2.2.7 THE NORTH EAST "DHARMASALA" STRUCTURE

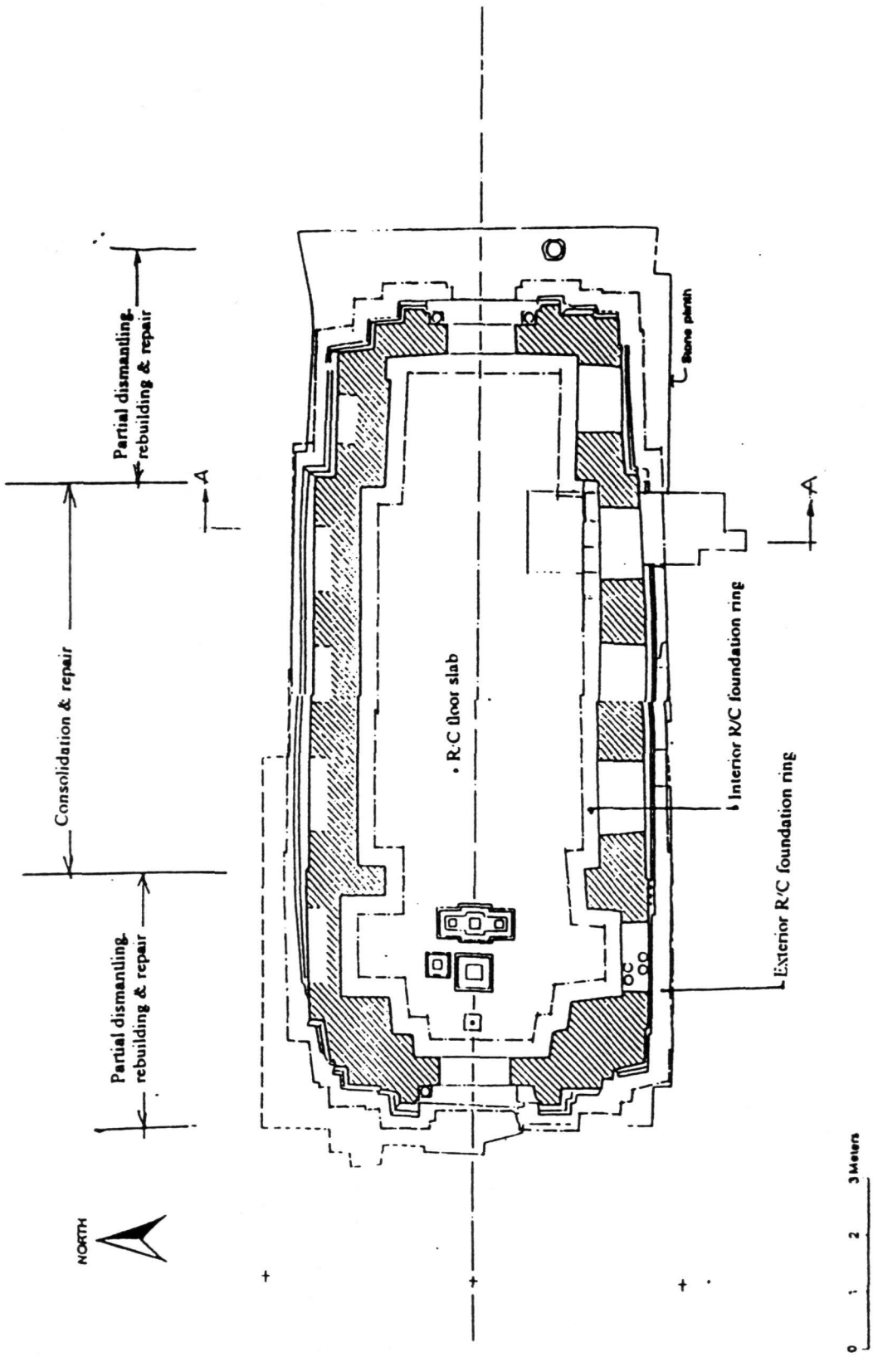


The freestanding two-level Dharmasala structure is often referred to as the 'biblioteque' or 'Temple of the Sacred Flame'. It is located in the eastern sector between the outer Enclosure Wall IV and Enclosure Wall III along the East West axial path; until recently it was completely hidden in jungle undergrowth. This unique structure is threatening to collapse and has been temporarily supported by structural scaffolding. WMF is campaigning to raise all the funds required to complete a repair program before any work commences. The work proposed is summarized below. *For previous studies please see Preah Khan Report V, Appendix A: p. 30 ff.*

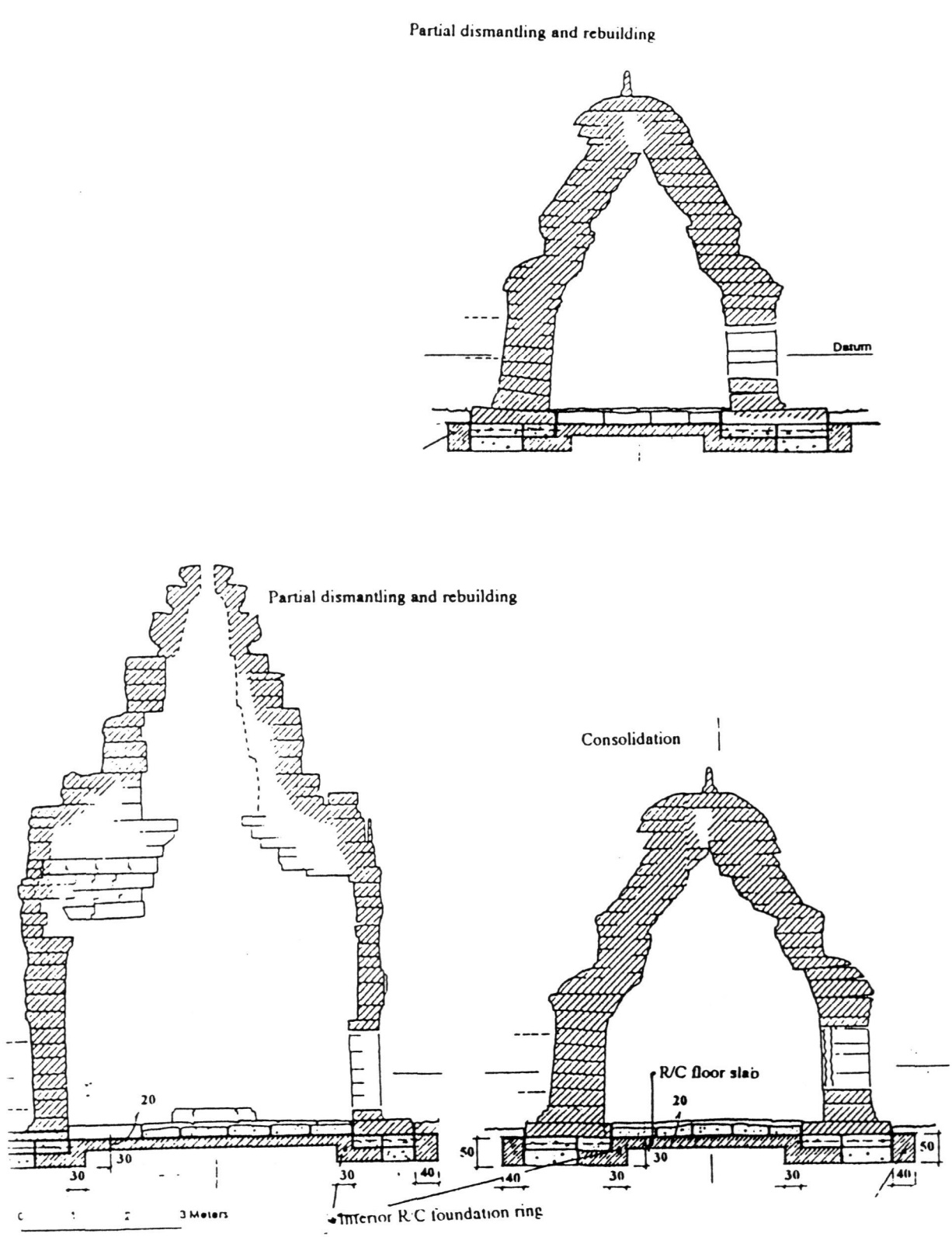
This unique independent stone structure, with its western tower, encapsulates nearly all the structural problems found in a Khmer monument. The main defects are failing foundations which are overtaxed by the lateral thrust of adjacent corbelled vaults. The corbelled stones have slipped and locked themselves into a new but stable position. The end walls to the East and West are very unstable and have separated from the main structure.

The WMF team has considered at length the most suitable stabilization program for the Dharmasala. Consideration was given to anastylosis, but this aggressive approach does not meet WMF principles and procedures adopted at Preah Khan. It is recommended that the present status of the structure is maintained by the placement of support foundations enclosing the existing inadequate foundations, with underpinning as required.

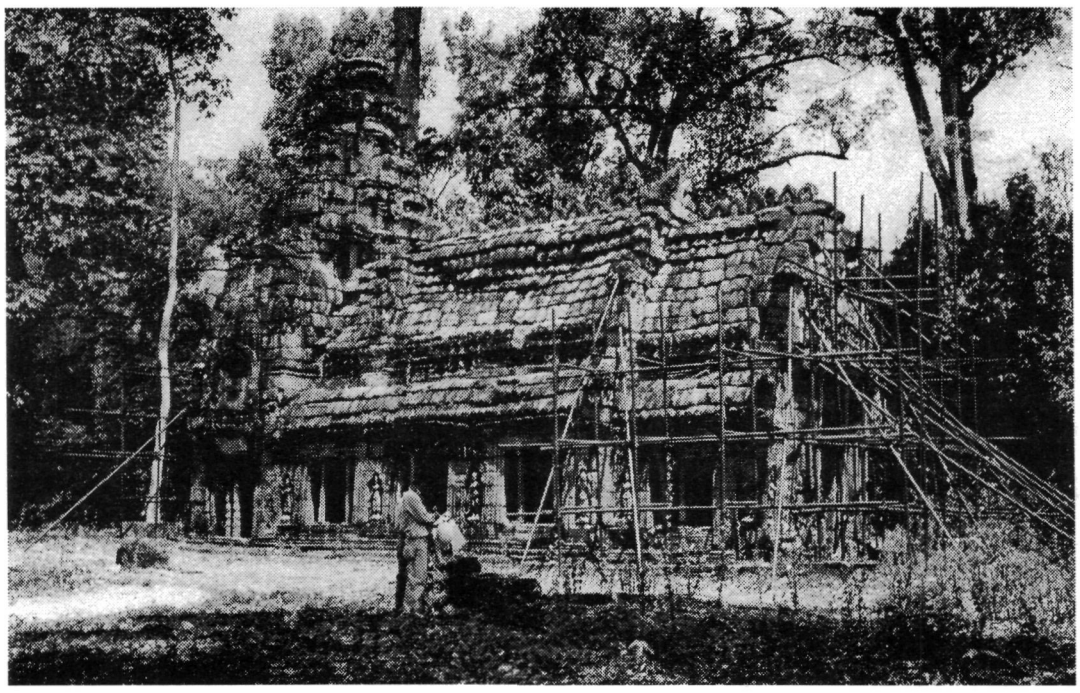
It is also recommended that the remainder of the structure above ground will be repaired and consolidated as needed through the careful realignment of stone blocks. Further support will be afforded by the insertion of reinforced concrete ring beams around the base of the tower or through the linking together of stone blocks with stainless steel ties to form a structural ring with the existing historic masonry. In some cases, especially on the northern side of the structure, it may be necessary to replace some of the missing structural stones. Below grade, reinforced concrete beams should be inserted to tie new concrete foundations together. Following these proposed interventions, the outward appearance of the structure and fabric of the Dharmasala will remain unchanged.



2.2.7a plan with proposed reinforcement



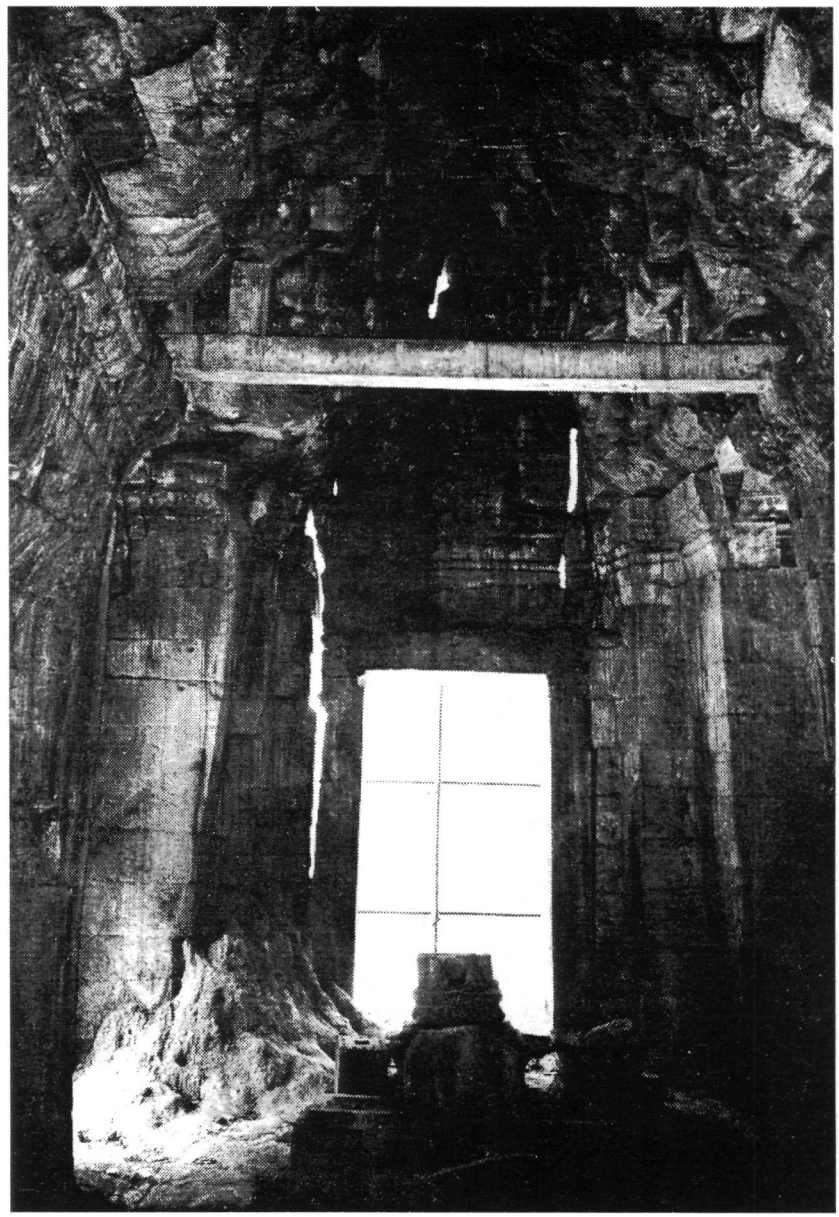
2.2.7b sections through corbelled vaults showing proposed consolidation



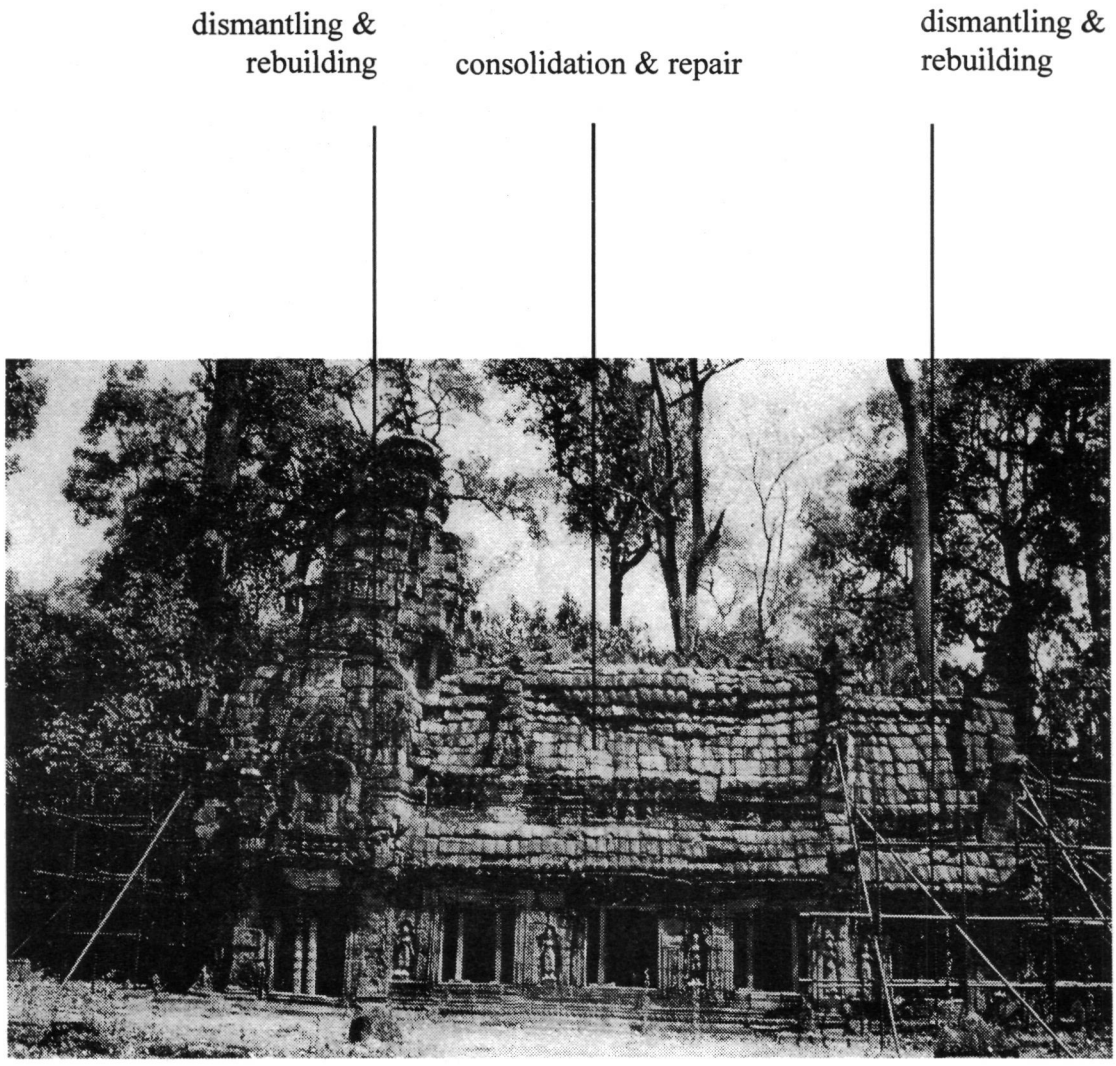
2.2.7c existing state of monument, exterior view

2.2.7d eastern section of monument, exterior view

2.2.7e western section of monument, exterior



2.2.7f western section of monument, interior



2.2.7g proposed interventions

2.3.1 STONE CONSERVATION TRAINING, P. PAGNIN

Conservation expert Paolo Pagnin of Venice visited the Preah Khan site during two missions, 12-27 January and 25 March to 8 April 1996. His activities centered around investigation of new and appropriate techniques for the consolidation and repair of broken stone, consisting mainly of sandstone and laterite. Successful methods were taught to the full time conservation supervisor and to the skilled work crews on site. *For full report, see Appendix A, section 2 under separate cover.*

Specific techniques developed during these 1996 missions for the continuing conservation activities at Preah Khan included:

- methodologies for gluing with epoxy resin
- injection of epoxy resin into holes bored for the insertion of stainless steel pins on broken lintels
- filling fractures with epoxy resin without dismantling broken element
- use of lime-based mortars for filling fractures and matching with original color and texture
- texture testing for replacement stone
- methods of preconsolidation
- pouring molten lead into fractures
- clamping and reinforcing using polypropylene rope
- mapping decorated surface finishes

Appropriate methods of stone cutting for resetting and repair were also developed with a special team of two skilled stonemasons, who were trained in the use of different chisels and methods for splitting and dressing laterite and sandstone blocks during the dismantling and resetting process. The necessary tools were forged by the Preah Khan blacksmith, and the permanent team's enhanced knowledge of these techniques has significantly broadened their ability to respond to consolidation issues appropriately.

Mr. Pagnin also initiated a program with the local architects to inventory and study the interior and exterior finishes at the intervention sites at Preah Khan. In April, painted wall decorations were discovered in the western central tower of the northern Vishnu Complex: a fragment, 15x30 cm, on a lime plaster base in a geometrical pattern, showing brush marks and multiple colors. This important finding strengthens the polychrome theory of interior decoration advanced by the team at Prah Ko Temple and leads to the revelation of a partial pattern of painted interior surfaces.

All these techniques were demonstrated and applied to fractured sculptures at Preah Khan. Repair of the over life-size free standing Dvarapala 'guardian' statue, which commenced in January, was selected as a demonstration project for many of the new techniques introduced by Mr. Pagnin during these missions. Prior to consolidation, the statue's right arm was detached from the monolithic torso and hanging from the shoulder by the exposed reinforcing bars. Various pieces of the right hand and forearm were found on the ground nearby, along with the club which the figure once held. The base was also fractured. An earlier intervention left steel clamps imbedded in the shoulder and hidden by cement mortar. Following the removal of the loosely attached arm, more than fifteen individual stone fragments were ready for consolidation and resetting.

Broken pieces were cleaned, realigned, and reassembled after being drilled centrally for the insertion of reinforcing fiberglass dowel joints, brought by Mr. Pagnin from Venice. Once all the pieces were reassembled and doweled, the sections were glued and precisely fitted into the main sculpture. The missing section was consolidated with epoxy mortar and finished with a 'local formula' mortar. This exercise allowed for the successful repair of the statue, the transfer of the techniques from Mr. Pagnin to the local full time staff, and the examination of the difference between laboratory and on-site repair methods. After the departure of Mr. Pagnin, architect Van Morin continued this repair project and continued to master the new techniques.

These processes were always carried out with local personnel and with the intention of forming a team able to operate autonomously.

Recommendations for further development of these techniques at Preah Khan include:

- check, develop, and perfect the technique of bonding further with the use of other adhesives which may speed up the work.
- check, control, and increase the understanding of mortar mixing and analysis on site.
- perfect the technique of fixing with the use of new materials such as Polypropylene rod or copper bars.
- initiate the local consolidation of severely altered stone with ethyl silicate, checking the results and teaching at the staff the technique.
- instruct all personnel in the importance of the aesthetic presentation of interventions, with more attention to detail.
- continue to check the results of the cleaning with a biocide and obtain objective data regarding commercial products fit for use.
- study the action of rain water in relation to the phenomena of micro-biological attack and attempt, if possible, to slow down growth, especially in the sculpted areas within the temple, hopefully using only the drip stones and the physical barriers.
- study how to isolate the cement subfoundation, using the non-capillary properties of the laterite and avoiding the impermeable barriers such as plastic.
- study and define the philosophy and methodology of intervention in cases where it is necessary to integrate where stones are missing (materials, methods, texture).
- sponsor a conference to focus attention on this project and to demonstrate that the approach of minimal intervention is actually the most appropriate philosophy of restoration.

2.3.2 STRUCTURAL CONSERVATION TRAINING, GAVRILOVIC

Expert structural stabilization consultant Predrag Gavrilovic of Skopje, Macedonia visited the Preah Khan site from 30 March to 23 April 1996 in order to advise and train the local staff regarding new techniques for structural intervention. *For full report, see Appendix A section 1 under separate cover.*

The training process involved hands-on repair and implementation of structural repair and consolidation procedures at the following locations:

- Hall of Dancers: southeast enclosure wall and eastern door
- East Gopura IV: southwest portico and northeast portico
- Temple east of central tower: column and corner
- Enclosure Wall IV: northeast section and stabilization of Garudas

Several locations were also designated for structural intervention:

- the Dharmasala
- Hall of Dancers: northwest sector and southwest corner of enclosure wall with portal frame
- East Gopura IV: south tower
- West Gopura IV: beam and column joint
- North Gopura IV: central gateway

Recommendations for urgent temporary consolidation and new material for additional testing were also developed. A general report was also generated to examine the characteristics of most common materials found at Preah Khan and used in structural interventions, the dynamics of beams and columns in compression, the loading of corbelled vaults, enclosure walls, and the properties of soil and foundations in the complex.

2.3.3 UNIVERSITY OF FLORIDA MEETING: REMOTE SENSING AT ANGKOR

Workshop On Radar Imaging And Cultural Resource Management At The Angkor Eco–Site
&
Symposium On New Technologies And Global Cultural Resource Management

Report of the Second Scientific Roundtable
University of Florida, Gainesville

April 15–19, 1996

WORLD MONUMENTS FUND
ROYAL ANGKOR FOUNDATION

For full report, see separate WMF symposium report.

BACKGROUND

In response to a proposal submitted jointly by the World Monuments Fund and the Royal Angkor Foundation on July 15, 1994, NASA and the Jet Propulsion Laboratory directed the space shuttle *Endeavour* to collect images of specific sites (cultural, natural, mixed, and archaeological) in swaths that began in southeastern Thailand and ran down through Cambodia to Vietnam's Mekong Delta and down to the South China Sea, with special emphasis given to the historical site of Angkor. The shuttle employed the SIR–C/X–SAR Earth Imaging Radar system during its September–October 1994 mission. *Endeavour* collected these images, as a first step in what was hoped would be a new way to assist in the monitoring, documentation, and management, as well as reinterpretation and analysis of the Historic City of Angkor.

The first scientific roundtable at Princeton was jointly organized by the World Monuments Fund and the Royal Angkor Foundation, in collaboration with the School of Oriental and African Studies of the University of London and the Outreach Program of JPL. The roundtable was aimed at assembling a research team, assessing the radar data collected, and determining criteria for analyzing the data.

RESULTS

The workshop at the Second Scientific Roundtable provided a forum for discussion of progress made over the last year. Three main areas were explored: data management, prehistoric, historic, and archaeological discoveries, and ecological finds. Throughout these analyses, the Angkor experts related their experiences using radar imaging as a new tool in their research.

GIS and Data Management

The Royal Angkor Foundation (RAF), under its chairman, Ambassador János Jelen, continues to develop ever–more sophisticated cultural and ecological information data banks for Angkor using a geographic

information system. The GIS facilitates the layering of different data related to a specific area. To this end, RAF has thus far combined radar band data on Angkor with SPOT and ERS satellite imaging and aerial photography to achieve 93 different views of the Angkor area. The Royal Angkor Foundation has added cartographic and topographical information to these layers along with newly amassed data from the 1992–93 UNESCO Zoning and Environmental Management Plan (ZEMP) at Angkor. RAF's GIS was a key resource in the workshop, where scientists worked hand in hand with Angkor experts to interpret the radar data of Angkor.

The future of the data base will involve an elimination of platform reliance. The data base will accommodate additional data sources and will accommodate more integration when needed. System mobility will be one of its key attributes. It will facilitate multiple users and a shared data environment. This GIS–based data system will be both hardware and software flexible and include modular sub–systems.

RAF intends to move beyond digital mapping to "managing the chaos" of the incredible amount of incoming data, to facilitate its application in numerous scientific fields, such as archaeology, hydrology, and ecology.

Prehistory, History, and Archaeology

Over the last year, Dr. Elizabeth Moore, department head for art and archaeology of Southeast Asia at the School of Oriental and African Studies, University of London, chose three areas from the Angkor radar data for intensive study: Puok, central Angkor, and the ancient capital of Hariharalaya. She described her purpose as two–fold:

> *"to characterize the scattering mechanisms as calculated for SIR–C data for known forms within these areas and eventually use the results to classify unknown areas, and to understand the use of the terrain and local hydrology in the transition from the prehistoric era to the era of historic settlement and water management."*

In these three areas, Dr. Moore identified and studied four 'site" types: dikes, proto–mounds and mounds, temples, and water (e.g. barays, tanks, inundated zones). Two of these historic sites are located in the central Angkor area, while one (Hariharalaya) is in the Roluos area that is southeast of Angkor, and the other is to the west, aligned along the north–south ancient river bed of the Puok. She also discovered ancient river beds immediately north of Lolei temple, a 9th century A.D. structure. Through the use of radar imagery, Dr. Moore was able to detect distinctive features of each site that had not been revealed by aerial photography and SPOT satellite imagery, and could not be detected by ground survey. These ancient settlements and features were not apparent from aerial or satellite remote sensing and many could not be explored on land due to the threat posed by land mines. Thanks to some recent data that has been processed by NASA for her, Dr. Moore is hoping to compare settlements in northeast Thailand with those around Angkor.

In both the workshop and symposium, historian and epigrapher Prof. Claude Jacques, Director d"Études at l"École Practique des Hautes Études, Paris discussed his use of SPOT satellite images in his work at Angkor. At the GeoPlan Center work stations, Prof. Jacques was able to compare these satellite images with the composite radar images of the site.

Regional Planning and Cultural Resource Management — Potential Related Technologies for Global Management

Professor R. Terry Schnadelbach, Chair and Professor of Landscape Architecture at the Department of Landscape Architecture, University of Florida, has studied the radar imagery of Angkor over the past year to try to understand why the Khmers located Angkor in its particular location and how the Khmers modified the land area to build a better civilization. Professor Schnadelbach has discovered new features in the ecology of the site, which will help scholars understand both the hydrology of the Angkor area and the Khmer civilization's management of water.

Professor Schnadelbach has found in the radar data the presence of a large alluvial fan that stretches out below the Kulen hills. The data shows very clearly how earth and stream deposits fan out and move toward the Tonle Sap. The alluvial fan traverses Angkor, going directly through the Western Baray. The radar image reveals unique patterns of sinkholes within the fan, where pockets of water caused the land to collapse. The radar also shows springs cropping up along the way as the water travels through internal aquifers on the way to the Tonle Sap. Understanding this system, the Khmers adopted their water regime accordingly, diverting the streams and taking advantage of the numerous springs.

Radar data has enabled Professor Schnadelbach to develop a theory to explain why Angkor was built at its particular site. He has compared data from soil borings conducted by Japan's Sophia University with the radar data and has determined that Angkor was built upon the site of an ancient beach, where sand deposits lay near the surface. The builders of Angkor probably liked this area of higher ground with its distinct vegetation.

Radar data of the area's plant life has convinced Professor Schnadelbach that Angkor's builders maintained an already–existing tree cover. They probably desired an arboreal canopy for shade in the tropical climate, he suggested. Thus, the "temple forest" vegetation now seen in Angkor Thom is not merely the result of an untamed jungle closing in on a neglected ruin. Professor Schnadelbach views Angkor as distinct from ancient cities in the West, where large areas of vegetation were generally cleared before urban construction was started.

Contrary to current belief, the elevated area of Angkor's Western Baray was not formed by sedimentation, according to Professor Schnadelbach. The radar data, layered with SPOT satellite imagery and topographic information, clearly shows that the walls of the baray were constructed to keep something besides water within the reservoir's boundaries. Professor Schnadelbach speculates that the elevated area of the baray served as an animal pen, possibly for water buffalo or elephants.

Radar Imaging as a Research Tool

The use of radar as a research tool is new and the Angkor researchers spent the last year learning about its application. Dr. Elizabeth Moore visited the Jet Propulsion Laboratory to work with Dr. Tony Freeman, Group Supervisor, Data Utilization and Outreach Group, in interpreting the radar data. Dr. Freeman instructed Dr. Moore how to use a scattering model containing red, green, and blue channels that reveal different features of the terrain. This model proved valuable to Dr. Moore as she studied prehistoric sites. (Dr. Freeman's paper, "What is Imaging Radar"" can be found at Appendix A.) Dr. Moore also found that the digitalization of the radar data allowed her to quantify the changes in land mass or foliage that she had already visually distinguished.

In the last year, Professor Schnadelbach was able to study radar images of the Tonle Sap taken by the space shuttle in the rainy and dry seasons, providing him with an invaluable contrast that assisted him in understanding the workings of the great fresh water lake.

Radar and the Tonle Sap

While radar has demonstrated new possibilities for researchers of Cambodia's past, the radar imaging of the Tonle Sap has great potential for the country's future. At a time when a plan for damming the lake's tributaries is being considered, the radar may offer a new and improved understanding of the life cycle of this unusual body of water. Using the radar data, Professor Schnadelbach discovered new features in the lake's tributaries near Angkor, indicating the historic roots of the Tonle Sap river. The radar also revealed nutrient–rich areas of the great lake.

"The Tonle Sap is the heart of Cambodia and it is essential that this heart is living...," said Cambodian Minister of State for Culture and Fine Arts H.E. Vann Molyvann as he commented on the radar imaging of the lake. The radar data may help Cambodia in its attempt to prepare the Tonle Sap for inclusion as a bio–reserve on the World Heritage List maintained by UNESCO.

Future Plans for Radar at Angkor

Due to budgetary constraints at NASA, no spaceborne radar missions are planned at the present time. NASA, however, is planning to augment its spaceborne effort with airborne radar activities.

In the fall of 1996, NASA/JPL will be flying its airborne radar system known as AIRSAR/TOPSAR on missions in Southeast Asia. Situated aboard a DC–8 jet, this system is capable of collecting data using a combination of polarizations and radar frequencies and of generating topographic height data (a fuller description of AIRSAR prepared by JPL can be found as Appendix C).

The World Monuments Fund will investigate funding opportunities to support an Angkor AIRSAR/TOPSAR mission, which would augment the data collected from the Endeavour. This type of mission would make use of radar's P–band, which can penetrate the tree canopy, and gather data not obtainable by radar's L–, C–, and X–bands used on the space shuttle mission. TOPSAR data would enable the construction of a computer–generated three–dimensional topographic map of the Angkor area. This type of data organization may allow researchers to identify critical sites and research subjects more effectively.

PRESENTATIONS

"The Case for Global Monitoring of Cultural Heritage Sites" by Ambassador János Jelen, Chairman, Royal Angkor Foundation

"Overview Description of Radar Imaging and Archaeology" by Dr. Diane Evans, Project Scientist, Jet Propulsion Laboratory, Pasadena, California

"Description of Angkor and Overview of History: The Importance of Remote Sensing for the Knowledge of the Angkorian Civilization" by Prof. Claude Jacques, Director, d"Étude, École Pratique des Hautes Études, Sorbonne, Paris

"Radar Imaging of Desert Regions" by Dr. Farouk El–Baz, Director, Center for Remote Sensing, Boston University

"Remote Sensing and Archaeology in Northwestern Greece" by Dr. James Wiseman, Chairman, Department of Archaeology, Boston University

"Problems & Potentials —The Chaco Canyon Experiment: The Application of Remote Sensing in the Context of World Heritage Sites" by Dr. Margaret MacLean, Director, Documentation Program, The Getty Conservation Institute and Mr. Dominic Powlesland, Consultant to the Documentation Program of The Getty Conservation Institute

"How the Greek Countryside was Divided in Southern Italy and Crimea: The Achievements and Potential of Remote Sensing" by Dr. Joseph Carter and Dr. Jon Morter, Department of Classics, University of Texas at Austin

"Remote Sensing in Borneo" by Mr. Alexis G. Thomas, Ph.D. student, Project Director, GeoPlan Center, and Research Associate, Department of Urban and Regional Planning, University of Florida at Gainesville

"Very Low Altitude Aerial Remote Sensing for Archaeological Sites and Features" by Dr. Douglas Comer, Chief, Applied Archaeology Center, National Park Service

"Workshop on Global Positioning for World Heritage Sites" by Dr. John Alexander, University of Florida at Gainesville

SYMPOSIUM CONCLUSIONS AND RECOMMENDATIONS

Following the presentations, the symposium participants convened to determine the lessons learned from the use of new technologies for global cultural resource management, the advantages presented by radar imagery; what organizational challenges needed to be met; and what next steps needed to be taken.

Major Advantages of Radar Imaging

The unique properties of radar imaging provide new avenues of analysis. For example, the use of radar interferometry for three–dimensional topographical mapping is a major advantage of this type of remote sensing. Radar imaging can be combined with other data types to provide a comprehensive analysis of cultural heritage sites. Radar data can be used to analyze environmental change and project hazardous conditions; it can assist in developing ecological controls of human sites; and it can be used to determine archaeological features such as rivers, roads, and settlements. In addition, the ground penetration achieved by radar imaging is an extremely useful tool for analyzing sites threatened by geological hazards such as volcanos, earthquakes, and floods. Overall, radar data is crucial for developing site context, monitoring, and management.

However, there are limitations to what information radar data can supply, for example it is not useful for interpreting large scale regions. Participants are aware that radar imaging and state-of-the-art technology will not solve all problems, but both are valuable first steps towards understanding past civilizations and present environments.

Organizational Suggestions

The symposium participants were united in advocating the sharing of information on the use of remote sensing for cultural resource management. It was stated that the technology alone is a means to facilitate cross–cultural collaborations.

The experts discussed various ways to establish centers for information–sharing. Data access of World Heritage sites and other sites should be made available on a continuous basis. Suggestions ranged from organizing a home page on the Internet's World Wide Web to serve as a base of operations, to establishing a network with others using the radar data, to developing a not–for–profit consortium of research institutions focused on heritage preservation and cultural resource management of World Heritage and archaeological sites. This consortium could take the form of a World Heritage Center or Documentation Center. A depository of all related information could also be established. These repositories of information would serve as a clearinghouse and be responsive to copyright issues. In preparation for these bodies, organizers must determine how its activities will be funded and sustained.

Symposium participants were encouraged to document and share their process in working with remote sensing data. They were urged to record and publish their work, and to use mediums such as CD–ROMS to do so.

The scientific round tables organized by the World Monuments Fund were an integral part of the organizational plan. It was proposed that a follow–up workshop be held in Cambodia and that the symposium participants should reconvene the scientific roundtable in one year, perhaps at Boston University.

Lessons Learned

Having reviewed the information conveyed over the week, the symposium participants discussed the lessons learned. Three main areas of agreement emerged: radar imaging should be augmented by other remote sensing methods; remote sensing is best utilized if undertaken in different seasons; and flexible and platform independent software is necessary to maximize results.

Radar imaging, where possible, should be used in connection with other remote sensing methods. The merging of radar and satellite data will be highly useful. Overall, remote sensing must be better linked to other forms of research. In analyzing the data, multi–disciplinary teams are the most effective and will draw out more information from the data.

There are definite advantages in the comparison of remote sensing in different seasons (multiple temporal imaging for seasonal change). The best conditions for radar imaging are believed to be hot/arid climates, but the radar images of Angkor show that wet/tropical regions are equally good subjects. Radar sampling shots have proved useful for analysis of the Cambodian lake, Tonle Sap, (and for dry land). Tree cover, growth rates, and movement patterns (fishing routes) have been revealed. To assist in these studies, Dr. Diane Evans's list of surface changes that can affect radar back scatter should be distributed.

Flexible and platform independent software is needed for data analysis. There is serious promise in multi–platform data consolidation. The symposium was reminded that a GIS is irrelevant if it does not contain accurate data.

Remote Sensing and Cultural Resource Management

As the theme of the symposium was the use of remote sensing to aid in the management of cultural resources, the participants expressed their concern that remote sensing data be used to assist the monitoring of sites and that the information gained through remote sensing be shared with cultural resource managers.

The opportunity exists at present to use available data to discourage negative impact to cultural resources. For example, it can be used for the monitoring of tourism development at Angkor, Petra, Chaco Canyon, the Kathmandu Valley, and Luxor. The technology should be applied where it most matters, such as on endangered sites — especially World Heritage sites — and bio–diversity reserves. The symposium participants intend to advocate quality in remote sensing services used for cultural resource management purposes.

Above all, data technology must be shared with cultural resource managers on the ground on a continuous basis, including thorough training and application. Pilot ground–based projects (with active local participation) should be used with all remote sensing applications, because there is no advantage to this application if there is no connection with the ground.

To facilitate the use of the data, training and community participation are important. Cultural and archaeological resource managers should be familiarized with remote sensing technology. Education should include case studies that help "disarm" skepticism and resistance to using remote sensing for the study of cultural heritage sites.

Goals and New Directions

The symposium participants agreed to certain measures intended to maintain the momentum in the use of remote sensing for cultural resource management. Various steps were outlined that centered on the collection of additional data, the sharing of all data, and widening the network of its users.

Various proposals for accumulating new data were set forth: 1) inform other commercial satellites (including those using radar) of the needs of cultural resource managers and issue an appeal for them to do their testing on cultural heritage sites, thus providing a good way of obtaining free data; 2) develop cooperation between the SPOT (French), German, Landsat, and Mons satellite programs with the NASA/JPL radar imaging program; and 3) work to secure other relevant remote sensing data, such as Russian and CIA high resolution material.

The sharing of information was a high priority. The relative advantages of the various remote sensing methods should be a significant element of this goal. The property rights of data should be shared with the local users. As discussed above, the organizational and informational networks should be improved.

Different sites were mentioned for special study. A focus on the Tonle Sap was proposed as a case study (as well as studies of Angkor Borei, Phnom Penh, and Kulen in Cambodia). The application of radar in disturbed areas, such as Rome and Los Angeles, was cited as another goal.

The importance of the burgeoning relationship with NASA/JPL was stressed. There is a need to convince NASA and its affiliates to further discuss methods of mutual assistance. NASA should think of cultural resource management as it plans remote sensing missions; therefore Dr. Diane Evans should add "cultural resource" to her "Beyond SIR–C/X–SAR" diagram.

The symposium participants agreed to engage NASA/JPL regarding the space agency's future airborne and spaceborne remote sensing missions. The next NASA project that might accommodate a fly–over of Cambodia is scheduled to be an AIRSAR/TOPSAR radar mission in October 1996. NASA's next major remote sensing spaceborne mission, utilizing the space shuttle, will likely be a military mission that includes a focus on topography.

The symposium participants also expressed an interest in other forms of remote sensing. They agreed to pursue a very low altitude remote sensing mission at Angkor, similar to the one described in the presentation of the National Park Service's Dr. Douglas Comer.

The participants concluded by agreeing to keep in closer touch in the future. They pledged to continue with the program outlined in the symposium until it firmly takes root.

SECTION 3

Appendices

PREAH KHAN STELE
K 908

For full text translation, see Appendix A under separate cover.

INTRODUCTION

The great Preah Khan Stele was discovered on the thirteenth of November 1939 by Maurice Glaize and was published in the *BEFEC* XLI, 1941, by Georges Coedes (pp. 255-301). It is worth noting that the article also presented reproductions of the stampings. One should also notice that G. Coedes did not include this edition in his "Etudes cambodgiennes." The introduction, to be seriously revised today, is particularly long, filling in pages 255-270.

TRANSLATION

The original text thus starts at Stanza XIX

XIX. "Having assembled the beauty of the egg of Brahman sprinkled with *amrta* and having placed it with the good signs in the palace which is its receptacle, the Creator created him with love following his own genius, certainly because intended to make an "emperor" with blameless qualities."

XX. "Laksmi, from whom one says she is unstable, linked by the insurmountable qualities of her soul, he has immobilized her in the Gynaeceum of his politics; having adorn her friend the Renown who moves in the directions, this one lead away to the end of the world the family of the king of the enemies."

XXI. "In love with what is correct, well known as experienced (old) for his prosperity and his good qualities, making good things, of whom the customs and the castes are well educated, destroying the enemy, having to be revered by the sovereigns[1], he was known from his childhood as a Panini."

[1] Double-meaning: "Loving the pure tongue, making good names by the *guna*, the *vrddhi* and the *vraddha*, making suffixes *kn*, which arranged the pronunciation of the Sanskrit letters, considering *durhra-* as irregular, for whom Shiva must be adorned, ..."

XXII. "With love, he himself gave to the Dharmaraja[2] 13,500 *grama*[3], but the son of the Dhrtarastra[4], even instigated by Krsna, did not even give five."

XXIII. "Aurvanala in the ocean of the enemy's army, fire of bush in the forest of weapons, moon for the blue lotuses[5], which are the kings of the leaning enemies, his eagerness had indeed the splendor of Narayana's[6] weapons."

XXIV. "The enemies, who had observed in the fight the extraordinary and invincible aspect of him when he was carrying his weapons[7], who closed the eyes[8] and from whom the snake-arms had let their weapons fall, used now, I think, the weapon called "flight", which they had forgotten for a long time[9]."

XXV. "The kings, having seen from front and side his black sword which he rendered marvelous in the fight, white from gold and red from blood, as frightened by the harm caused by Indra's[10] bow, dropping their weapons, prostrated themselves."

XXVI. "Like the pond - field of battle was corrupted, inaccessible, of which the formidable **[redoutable?]** emplacement **[location?]** was hidden by tight rains of weapons, Laksmi was becoming like a bee, describing circles in her flight around the full-blown lotus of her palace[11]."

XXVII. "To his many warriors, he gave the royal residences of the enemies' kings[12], resplendent from very high palaces; to the wild animals haunting his own forests, he gave, I think, the enemy's forest[13]; to the war prisoners, he gave his own forest, generous and showing his moral equilibrium[14]."

---

[2] Despite Georges Coedes opinion, it seems to me impossible that here Dharmaraja would not be the Buddha.

[3] One will retrieve this number in the St. CLXXVII. Starting at St. XXIII, it is the war that is described and I wonder why it mentions so soon the "donation of 13.500 *grama*" to the Buddha before talking about this war: indeed, one will come back soon to the generosities of the king and it is a fact that they are not generally described so soon in the poem. Yet, one finds the same number of *grama* in St. CLXXVII, which correspond to the total of the *grama* of St. LXXIII and CXLI. But it must be underlined that one is here in the *prasasti* and that it does not say the truth, because the indicated stanza specify that the villages were given "by the king and the owners of *grama*". I do not understand the place of this stanza, but one has further on, St. XXX, a stanza of at least as unwonted place.

[4] "It is about Duryodhana and his refusal to follow Krsna's advice which bounded him to share the power with the five Pandava (MBH, V, 124-128)." (G. Coedes' note 6, p. 286).

[5] Which flower at moonrise.

[6] For Bhatt, "no connection, only beauty!" **[in English in the text]**; but I would still like to find a relationship between Narayana's weapons and what is said here (*cf. Mahabharata, Dronaparvan, Narayanastramoksaparvan,* SORENSEN, p. 511, P. C. ROY, vol. VI, pp. 455-494).

[7] *Cf.* previous stanza.

[8] Dazzled and frightened.

[9] Manifestly there is here an historical hint.

[10] The rainbow. For the legend of Indra's bow, see P. V. KANE and *Sabdakalpadruma.*

[11] Laksmi, unable to land on the pond, arrives in her palace: therefore, the war is over, as one furthermore sees it in the next stanza.

[12] One sees well this way that it is about Khmer enemies, as he would not have given far abroad the properties of his enemies.

[13] One has here a realistic detail: the prisons were installed in the forests.

[14] This stanza clearly marks the end of the war, as the king is at this stage distributing rewards to his faithful companions.

XXVIII. "To the wise men he had favored with wealth, this "political stay"[15] gave his own daughters, attractive by their beauty[16]; but the king of Cedi (did it) to Hutavaha [Agni] only after receiving as payment a portion of him[17] (and) Gadhi (did it) to Rcika (only after receiving as payment) numerous horses[18]."

XXIX. "Rama and himself have both accomplished tasks for the gods and the men: both had hearts entirely dedicated to the good of their father, both defeated a Bhargava[19]; the first made a road out with stone in order to allow monkeys to cross the ocean, while the second made one out of gold[20] to allow men[21] to cross the ocean of existences."

XXX. "The two golden "Lords of Dance" which they had had placed in front of the golden Snake were like the two Raghava[22] immediately liberated from the ties of the snakes due to the fall of the arrows of Indra Victorious[23]."

---

[15] One sees well here why he is giving his daughters: even if it is a well-known fact for the kings and practiced well elsewhere than in ancient Cambodia, one observes here that the epithets are not casually distributed.

[16] Coedes' interpretation, bringing *dhimatsu* to *nitinilayo*, is also possible, but would render less well the opposition I further on underline. Grammatically the two are possible. Yet, if one pushes the opposition with what follows, one notices that not only do they not ask for dowry, but that his daughter are given in addition to donations of his part. One should yet maybe even translate: "despite he had honored them with richness...", a little as G. Coedes does.

[17] The story as it is here suggested is difficult to locate. The *Mahabharata* tells the story of Sudarsana, daughter of Nila (*alias* Duryodhana, king of Mahismati), of whom Agni fall in love with and whom he married; his father had yet required from Agni that he always stood next to him. Yet this king, as G. Coedes underlines it, was not king of the Cedi. Was there another existing version of this story available to the Khmers?

[18] Ghadi was the son whom Kusanabha obtained his wife from, l'*apsaras* Ghrtaci, after having had 100 daughters (VETTAM MANI, under *Gadhi*; cf. *Mahabharata*, III, 125).

[19] Historical reference; cf. G. Coedes. The *bhargava* defeated by Rama is Parasurama, incarnation of Vishnu in order to destroy the *ksatriya*. The story of the defeat imposed by Rama is told in diverse forms.

[20] That is to say with his generosities (or with the Preah Khan temple? *cf.* multiple references).

[21] Notice here the opposition point by point: stone/gold, monkeys/men, ocean/ocean of existences.

[22] Rama and Laksmana.

[23] References in G. C. (*Ramayana*, VI, 44 sq.).

There is not any indication on the location where these statues were erected. In any case they must not have been in the Preah Khan, of which one only speaks later on. As the text says that these statues are of gold (or gilded bronze...), they may not have been very big. On the place of this stanza, cf. *supra*, St. XXII **[?]**.

XXXI. "Rama and Bhisma, as one knows, have obtained a glorious praise from their father descended in a hurry[24] from the sky; but him, which (praise has he not received from his father), honored without respite as Svayambhu, the "rich of the four arms" and Lokanatha[25]."

XXXII. "In this receptacle of the enemy's blood where he had taken away Jayasri[26] in the fight, he founded a town **[city?]** given this name, which shines, changing the color of a part of the soil with his precious stones, his lotuses and his gold, as if today still it was coated with blood.[27]"

XXXIII. "To Prayaga, one must go because of the presence of two *tirth* where one does good actions for the purification of men; what **[is there?]** to say about the city of Jayasri, rich of the *tirtha* of the Buddha, of Shiva and of Vishnu![28]"

XXXIV. "This king Sri Jayavarman has opened the eyes of the Lord of the world[29] named Sri Jayavarmesvara, in "*veda* - moon - moon - form"[30], under the features of his father."

XXXV. "All around the noble Avalokitesa which is in the center, he has installed 283 divinities[31]."

Here starts a list of divinities which, added to the indications of the "small inscriptions", allow to have a precise idea of the temple's organization.

XXXVI. "This king has installed on the east side three divinities, of which the first is Sri Ttribhuvanavarmesvara."

XXXVII. "In the south region, he has installed 20 divinities plus twelve[32], which start with Sri Yasovarmesvara."

---

[24] I refer here to the *Gayamahatmya*, because I know it well: for Rama, chap. VII, St. 74 to 78 (p. 246-249); for Bhisma, chap. VII, St. 71 to 73 (p. 244-245).
[25] *Cf.* G. C.'s explanations *BEFEC* XLI, p. 288 n. 2; but one finds here the three gods Lokesvara, Vishnu and Shiva (here named Svayambhu) from St. XXXIII.
[26] His victory plus his throne, not necessarily taken back by the Chams... *Cf.* yet Stanza CLXIX, where it is the Preah Khan *baray* which is compared to a lake of blood.
[27] I understand this Stanza as indicating that the last fight against the Chams (and perhaps a few Khmers...) took place in the Preah Khan domain, and more precisely of the one of the temple. From there I deducted, and this still very much appeal to me, that Tribhuvanadityavarman's palace (and before it, with other arguments, Yasovarman II's) stood there.
[28] One take up again here the affirmation, already found in above Stanza XXXI, of the "pantheon**[-like?]**" aspect of Preah Khan; but one does not speak of the kings' temple (located South).
[29] Note that *Lokesa* could be the equivalent of the Khmer *kamraterijagal.*
[30] 1113 *saka*, thus 1191/92 A. D.
[31] It is compulsory to count within this number Jayavarmesvara of St. XXXIV. *Cf.* St. XLIII which gives the total of gods.
[32] 20 + 12: Khmer way of counting with the twenty.

XXXVIII. "To the west, he has installed 30 divinities, starting with the image[33] of Sri Campesvara; to the north, 40, starting with a *Sivapada*."

XXXIX. "a divinity in the rice shop and ten in the "passages"[34], four in the "resthouse"[35] and three in the hospital[36];"

XL. "at the doors of the four cardinal points[37], there are twenty four divinities; and these gods all together form a total of four hundred thirty."

XLI. "In the island of Rajyasri, with a "thousand *linga*"[38], there are fourteen of them; in the two small reservoirs and in the Yogindravihara, there are sixteen of them in each;"

XLII. "in the *caitya* and the *valabhi* of Gaurisrigajaratna, on the margin of Jayatataka[39], there are twenty two divinities;"

XLIII. "and a god named Visvakarman in the house of the *aya*[40]. All together form a total of five hundred fifteen."

XLIV. "Essential[41] daily shares of the *puja* of all these gods, starting from Lokesvara[42]: white rice good to be cooked[43], 75 *khari* and 1/2 *drona*...."

---

[33] Campesvara is a name of Vishnu. *Cf.* with the name of Campesvara, the word *kanti* in K 293 (18) and K (BC 12). *Cf.* my thesis, p.

[34] *Cankrama* is formed on the intensive of the root KRAM- and means "promenade".

[35] *Upakarya*: litt. "(location for the assistance", thus, maybe, "royal tent" or "caravanserail"; one sees that the "house with fire", considered as *dharmasala* or "resthouses", are other sanctuaries.

[36] The number 3 is awaited for a hospital (even though the total of divinities given by the Ta Prohm St. CXVII, thus **[soit?]** 798 gods for 102 hospitals, give an average of 7,82 gods per establishment). Furthermore, one has not found, to my knowledge, the characteristic chapel of the Preah Khan hospital, neither, of course, the stele which should mark its location.

[37] It is about the doors of the town **[city?]** and the "small inscriptions" confirm this number.

[38] One must probably understand that the "thousand *linga*" is comprised in the number of fourteen divinities.

[39] It is not sure that it was the temple of Gaurisrigajaratna that was "on the margin" of the Preah Khan *Baray*; if it was the case, one can think of several sanctuaries, in particular Ta Som.

[40] *Cf. BEFEC* LXX, p. 96-97.

[41] *Angani* is opposed to **[conflict with]** *upakarani* of Stanza XLIX.

[42] Thus [soit?] 515 (*cf.* previous stanza which makes indeed the total; partial totals in the St. XXXV and XL).

[43] Compare to the ration given at Ta Prohm; St. XXXVIII: 73 *khari*, 2 *drona* and 2 *prastha* of husked rice for 263 divinities. One is surprised that the quantity indicated for Preah Khan is only slightly superior to the one of Ta Prohm, despite almost twice more divinities at Preah Khan.

John Sanday ..... WMF Field Director

TECHNICAL TEAM

Dr. Predrag Gavrilovic (Macedonia) ..... Consulting Engineer
Dr. Paolo Pagnin (Italy) ..... Materials Conservator

LOCAL TEAM

Ouk Samon ..... Chef de Chantier
Lek Sareth, ... Assistant Architect
Chan Chamroen ..... Archaeologist
Ms Cheam Phally ..... Assistant Architect
Ms Chhun Soma ..... Assistant Architect
Var Morin ..... Assistant Architect
Heng Kimheng ..... Assistant Architect
Kussom Sarun: ..... Administrative Assistant

PREAH KHAN PROJECT April 1995 Page 1 of 3
World Monuments Fund
Drawing Record List

No.	Date	Title/Description	Size	Sketch	Archaeological	Architectural	Engineering	Illustration	Commentary
1	Jan-95	NW Portico East Gopura IV	20x20	x					
2,3	Jan-95	NW Portico Floor Plan	42x58		x				
2	Jan-95	NW Portico Base	14x12	x					
4	Jan-95	NW Portico Roof Plan	25x25		x				Stone Numbers
5	Jan-95	NW Portico West El	23x33		x				
6	Jan-95	NW Portico South El	42x29		x				Pencil & St. No.
7	Jan-95	NW Portico North El	42x29		x				Pencil & St. No.
8	Jan-95	NW Portico Misc Stones Rebuild	42x29		x				Pencil & St. No.
9	Jan-95	NW Portico Fronton Elevation	42x29		x				(superseded)
10	Jan-95	NW Portico Fronton Elevation	23x40	x					
11	Jan-95	NW Portico Floor Plan	21x30					x	
12	Jan-95	NW Portico South El	21x30					x	Scaffolding
13	Jan-95	NW Portico West El	21x30					x	Incomplete
14	Jan-95	NW Portico South El	15x23					x	Mosaic Photo
15	Jan-95	NW Portico Floor	18x24					x	Mosaic Photo
15	Jan-95	NW Portico Floor	14x18					x	Mosaic Photo
16	Jan-95	SE Half Vault H of Dancers	14x21	x					
17	Jan-95	SE Half Vault Floor Plan	25x28		x				
18	Jan-95	SE Half Vault North El	25x36		x				Pencil & St. No.
19	Jan-95	SE Half Vault South El	25x36		x				
20	Jan-95	SE Half Vault Section	19x30		x				w/Geo Overlay
21	Jan-95	East Encl Wall N of E Gopura	25x54		x				El/Section
21A	Jan-95	East Encl Wall Section	25x35		x				
22	Jan-95	East Entrance Plan	20x29					x	R Yimsut
22	Jan-95	West Entrance Plan	20x29					x	R Yimsut
23	Jan-95	Hall of Dancers Plan	21x30	x					Tru-wall cracks
24	Jan-95	Hall of Dancers Plan	21x30						"French Photocopy"
25	Jan-95	Hall of Dancers Plan	21x30	x					PG/KLS Notes
26	Jan-95	Garuda Inventory Form	25x36					x	
27	Jan-95	Garuda Location Plan	29x42	x					
28	Jan-95	Garuda Geometry El	13x21					x	
29	Jan-95	Adopt a Garuda Poster	21x30					x	
30	Jan-95	Preah Khan 8 Jan Tour Plan	21x30					x	
31	Jan-95	Title Block Sample	10x36					x	
1,2	Apr-95	Hall of Dancers Floor Plan	42x58			x			
3,4	Apr-95	Hall of Dancers Separ. Struct	42x58					x	Keyed to forms
5	Apr-95	Hall of Dancers Sep Struct Forms	23x33						
6	Apr-95	Hall of Dancers Roof Plan	29x41			x			
7to10	Apr-95	Hall of Dancers Floor Plan	57x84		x				
11,12	Apr-95	Hall of Dancers EW Section	30x24		x				
13	Apr-95	Hall of Dancers NS Section	30x41		x				
14	Apr-95	Hall of Dancers NS Section	30x41		x				
15	Apr-95	Hall of Dancers SE court	30x41		x				Section Look S
16	Apr-95	Hall of Dancers SE court	6x7	x					Col Side Support
16	Apr-95	Hall of Dancers SE court	21x16	x					Water God
16,17	Apr-95	Hall of Dancers SE court	21x50		x				S El St. No.

No.	Date	Title/Description	Size	Sketch	Archaeological	Architectural	Engineering	Illustration	Commentary
18	Apr-95	Hall of Dancers SE court	29x42		x				Sec Look E
19	Apr-95	Hall of Dancers SE court	29x42		x				Sec Look E
20	Apr-95	Hall of Dancers SE court	29x42		x				Sec Look W
21	Apr-95	Hall of Dancers NW court	29x42		x				Stone No.
22	Apr-95	Hall of Dancers SE court	29x42		x				Stone No.
23	Apr-95	Hall of Dancers NE court	29x42		x				Stone No.
24	Apr-95	Hall of Dancers SE court	27x30					x	Isometric of repair
25	Apr-95	Hall of Dancers SE court	27x30	x					Cubit Nave Geo
26	Apr-95	NW Porticoe E Gopura IV	17x18			x			Fronton Recon
26	Apr-95	NW Porticoe E Gopura IV	22x29					x	Vault top streng
26	Apr-95	NW Porticoe E Gopura IV	9x11	x					Stone Patch, N El
27	Apr-95	NW Porticoe E Gopura IV	18x23					x	Jt Clos Med Dr
27	Apr-95	NW Porticoe E Gopura IV	21x28					x	Kulen Lintel
28	Apr-95	Central Vault E Gopura IV	29x42	x					North El
29	Apr-95	Central Vault E Gopura IV	29x42		x				W El
30	Apr-95	Central Vault E Gopura IV	29x42		x				W El St. No.
31	Apr-95	Central Vault E Gopura IV	29x37		x				W El
32	Apr-95	Central Vault E Gopura IV	29x37		x				S El Int
33	Apr-95	Central Vault E Gopura IV	29x37		x				Roof Pl St No
34	Apr-95	Central Vault E Gopura IV	29x37		x				Roof Pl St No
35	Apr-95	Central Vault E Gopura IV	17x18	x			x		Lift Lintel
35	Apr-95	Central Vault E Gopura IV	17x18	x			x		Lift Lintel
36,37	Apr-95	Neak Pean-Baray Plan	30x60				x		
38,39	Apr-95	Neak Pean-Sec at Pk Pyke	12x61			x			
40-45	Apr-95	Neak Pean-Sec Look N	12x368			x			
46,47	Apr-95	Neak Pean-Sec Look E	12x170+			x			
48	Apr-95	Neak Pean-Plan Foun House	29x42			x			
49	Apr-95	Neak Pean-E Foun House El	17x29		x				
49	Apr-95	Neak Pean-E Foun House El	17x29		x				
50	Apr-95	Neak Pean-Fount House El	29x42		x				
51	Apr-95	Neak Pean-Fount House El	29x42		x				
52	Apr-95	Neak Pean-W Foun House	29x22		x				Int El
52	Apr-95	Neak Pean-E Foun House	29x22		x				Int El
53	Apr-95	Neak Pean-S Foun House	29x22		x				Int El
53	Apr-95	Neak Pean-N Foun House	29x22		x				Int El
54	Apr-95	Neak Pean-Later. House	29x42		x				
55	Apr-95	Enc Wall IV Exist Cond	29x42					x	Survey Plan
56	Apr-95	Stele Position Plan	21x29		x				
56	Apr-95	Stele Position Sec	15x20		x				
57	Apr-95	Encl Wall IV Sec	16x21				x		N of E God
57	Apr-95	Encl Wall IV Garuda	29x22	x					
58	Apr-95	Hall of Dancers-Garuda	23x29	x					Entablature
58	Apr-95	N Promanade-Garuda	23x29	x					Balustrade
59	Apr-95	Hall of Dancers-Apsara	23x29	x					Lintel
59	Apr-95	Hall of Dancers-Apsara	23x29	x					N Ext Door
60	Apr-95	Hall of Dancers-Apsasra hand	23x29	x					Small find

Drawing Record List

No.	Date	Title/Description	Size	Sketch	Archaeological	Architectural	Engineering	Illustration	Commentary
60	Apr-95	Hall of Dancers-Apsara Torso	23x29	x					Small find
61	Apr-95	Wood Drawing Cabinet	21x29			x			
61	Apr-95	South Vault E. Gop IV	15x26	x					N El
62	Apr-95	Preah Khan Brochure	29x42					x	Camera Ready
63	Apr-95	Hall of Dancers SE Court	29x42	x		x			Rest Section
64	Apr-95	Hall of Dancers Roof plan	29x42	x		x			Supersedes #6
65	Apr-95	Hall of Dancers Roof plan	29x42	x		x			Exist Cond
66	Apr-95	Hall of Dancers SE court	29x42		x				Vault roof plan
67	Apr-95	Hall of Dancers SE court	20x29	x					Col head detail
68	Apr-95	Hall of Dancers Floor plan	29x42			x			Wk Plan students
68A	Apr-95	Hall of Dancers chart	21x29						Wk Plan students
69	Apr-95	Angkor Wat Vault	27x29	x					N library
70	Apr-95	Vishnu Complex Floor Plan	29x42			x			Base dwg
71	Apr-95	Vishnu Complex Roof Plan	29x42	x		x			Restored
72	Apr-95	Vishnu Complex Roof Plan	29x42	x					Exist Cond
73	Apr-95	Vishnu Complex Floor Plan	29x42	x		x			Struct Separt
74	Apr-95	Vishnu Complex Floor Plan	29x42			x			Collapse Areas
75	Apr-95	Vishnu Complex Rm 6 Section	27x36			x		x	Orig/Exist Cond
76	Apr-95	Vishnu Complex Vault Sections	29x42	x					

anastylosis: a method of restoring a monument distinguished by rebuilding the structure using the original methods and materials

Angkor: ('city or capital') an ancient capital in Cambodia that was the main center of the Khmer Empire from AD 802 to 1432

apsara: a female divinity; heavenly dancer; celestial nymph who entertains the gods and is the sensual reward of kings and heroes who die bravely

Banteay: ('fortress') the name given to a temple with an enclosing wall

baray: ('lake') a large man-made body of water surrounded by banks of earth; reservoir

causeway: a raised road across a body of water

corbel: a method of spanning an opening used by the Khmers for arches; it consists of a overlapping arrangement of stones, each course projecting beyond the one below

dvarapala: a guardian often standing and holding a club or mace; sculpted in the round and frequently at the entrance to a temple

fronton: the triangular vertical face used decoratively above a lintel or over a portico or other entrance

Garuda: a mythical creature depicted in Khmer art with the arms and torso of a human and the beak, wings, legs, and claws of an eagle; an enemy of the naga; Vishnu's mount

gopura: an elaborate gateway to a temple in the south of India; it serves as an entrance pavilion in walls enclosing a temple

Khmer: the ancient indigenous people of Cambodia

laterite: a residual product of rock decay abundant in the soil of Cambodia and Northeastern Thailand; characterized by a porous texture and a red color; harden on exposure to air; used as a building material, particularly for foundations of Khmer temples

lintel: a crossbeam resting on two upright posts; on a Khmer temple the lintel is above the door or window opening, directly below the pediment

Phnom: the Khmer work for 'hill' or 'mount'

pilaster: a column used on the side of an open doorway that projects slightly from the wall

portico: an entrance porch

preah: 'sacred' 'holy'

stele: an upright slab bearing an inscription

stucco: a plaster used decoratively for covering walls (brick wall in Khmer architecture)

Tonle Sap: ('sweet water') a freshwater sea in western Cambodia that is linked with the Mekong River by the Tonle Sap River

vault: an arch extended in depth

Vishnu: one of the three major Hindu gods; the preserver and protector

wat: a Thai word meaning 'temple'