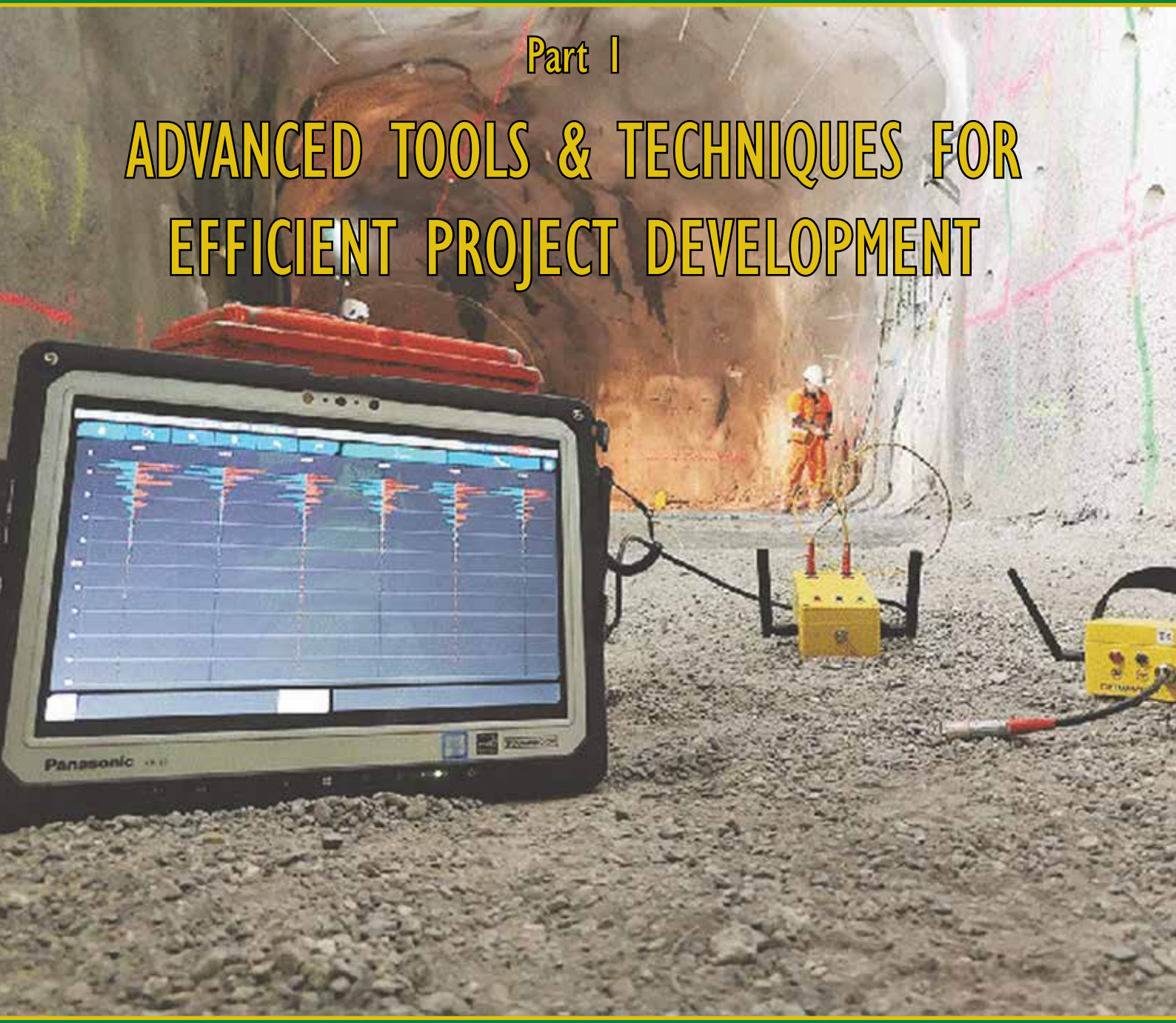
Water Resources Publication Series on Hydroelectric & Pumped Storage Projects

Part I

ADVANCED TOOLS & TECHNIQUES FOR EFFICIENT PROJECT DEVELOPMENT



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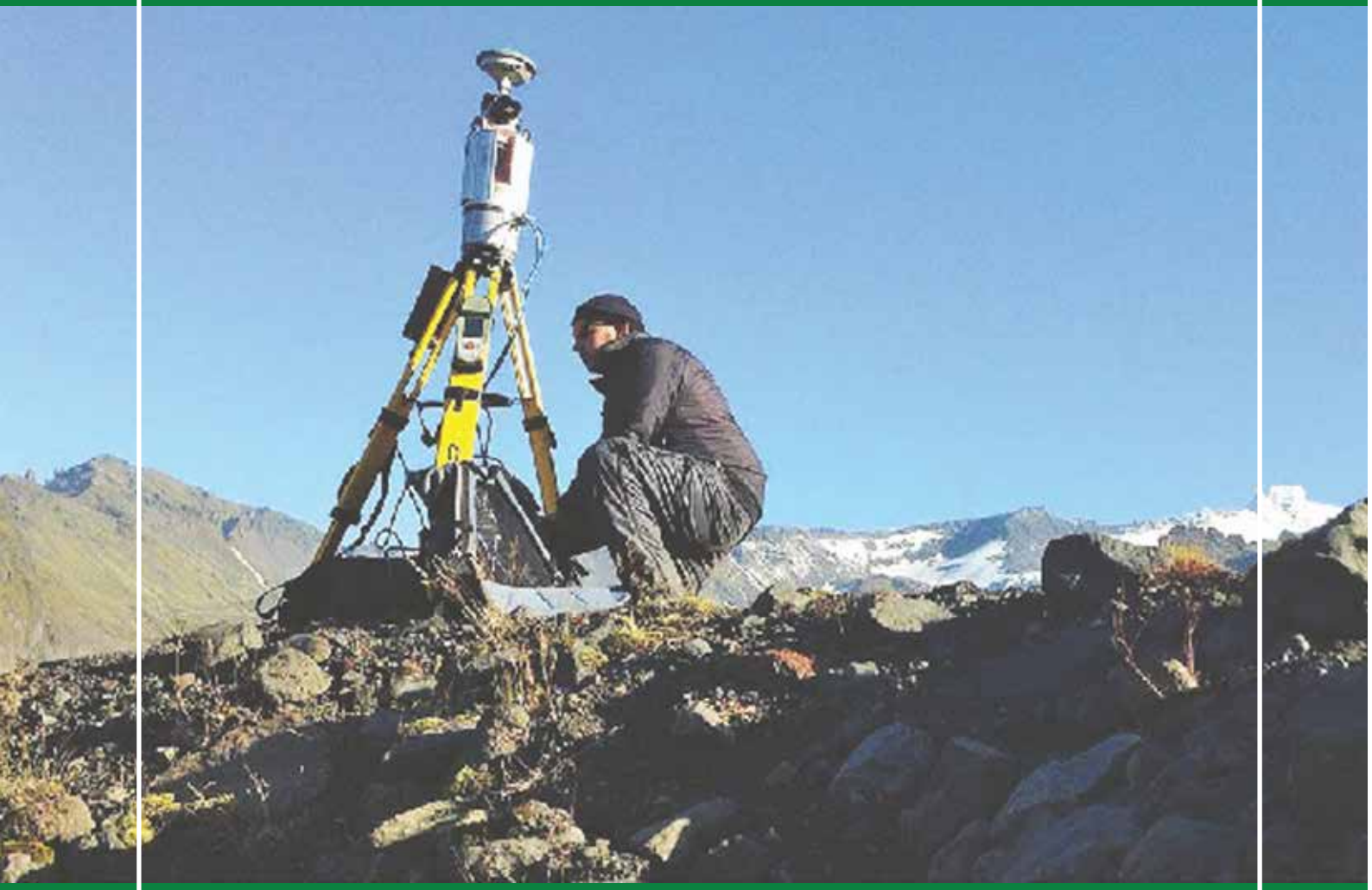

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DISCLAIMER

This book titled "Advance Tools & Techniques for Efficient Project Development" is a compilation of information and data available in the various texts under 'References' as well as from websites. The book is prepared for general information purpose. It is no way intended for any other purpose. Though all efforts have been made to present the data correctly, there may be inadvertent errors. It does not constitute legal, engineering or technical advice.

Contribution made by all the committee members of Research Scheme on Power (RSoP) of Central Power Research Institute (CPRI), undertaken by CBIP previously in 2016, is duly acknowledged.

Front Cover *:*

Advanced TSP technique for predicting media ahead of tunnel face

Back Cover*:*

State-of-the-art DGPS system for precise terrestrial survey in hilly region

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FOREWORD

As India shifts towards cleaner energy sources and the demand for energy rises, hydropower, especially pumped storage project (PSP), is gaining significant traction, particularly for enhancing system flexibility. In this regard, recent Government of India policy initiatives and guidelines are expected to invigorate the sector in the coming years.

However in the past, it has been observed that complex geological sites, especially the Himalayas, pose major challenges in setting up hydropower projects, and unforeseen geological conditions remain major contributor to time and budgetary overruns -in establishing safe and sustainable projects.

This book presents detailed information about the best practices and advanced tools & techniques, presently available globally, for enhancing efficiency of investigation as well as construction of hydropower projects involving surface and underground works. It introduces to the readers -the merits of latest instruments and techniques, that would be helpful in making realistic assessments of the site geological conditions & associated geotechnical issues, and brings out the advantages of application of the advanced methodologies and appropriate construction equipment available in today's time.

In execution of hydropower projects, detrimental geological conditions are major contributors to time and budgetary overruns. Many are the result of inadequacy of geological investigation and incompetence in dealing with problems once they have arisen. Accordingly, planned applications of the advanced tools and techniques, available in the present time, will be highly helpful towards eliminating the "geological surprises" and establishing a safe project within the scheduled time frame and finance.

Presently in hydropower development sector, there is a wide gap between the practice followed and the state-of-the-art available. The valuable information provided in this publication will greatly help in bridging this prevailing gap. Knowledge about the available advanced tools and techniques and their judicious implementation will be beneficial for the project developers in effectively tackling the adverse issues -boosting thereby, the level of confidence in timely establishment of safe and sustainable hydropower projects, in complex setups.

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Hydro PSPs are vital for the energy transition, as they allow excess electricity generated during off-peak hours to be stored in the form of water in elevated reservoirs. This stored energy can then be used back during non-solar hours peak demand periods, ensuring a reliable, consistent, and flexible power supply. The Central Electricity Authority (CEA), under the Ministry of Power, Government of India, has made ambitious plan to boost energy storage capacity drastically in the country, making a major contribution to grid reliability and supporting India's ambitious renewable energy goals. Despite having only 3.5 GW of operational hydro PSP capacity currently, development has begun in mission mode and by 2032 the figure is projected to reach 55.60 GW. This has been made possible by CEA as it has taken various measure in cooperation with all stakes holders. The DPR has been rationalized. Process on concurrence has been made transparent and quick. CEA concurred 7.5 GW PSP Project in 2024-25 and is targeting to concurrence of around 25 GW during 2025-26. Pump Storage Potential is also increasing every month and presently India's hydro PSP potential exceeds 200 GW, driven by self-identified projects.

I wish to compliment the members of the 'Publication Committee', for the dedicated efforts made by them in bringing out this valuable document. I trust that this comprehensive book brought out by CBIP, will be of immense interest to all project developers in general and in particular to those presently involved in establishment of hydroelectric, pumped storage, and allied projects.

(Ghanshyam Prasad)

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PREFACE

There is a broad feeling that, hydropower projects - both hydroelectric and pumped storage schemes, take longer time than the schedule and delays are often attributed to "geological surprises". While execution of projects, unforeseen geological conditions and associated geotechnical problems are often major contributor towards time and budgetary overruns, especially in complex geological settings. However, in spite of attempts to deal with these situations, the issues persist. Therefore, in order to minimise delays, it is imperative that realistic geological and geotechnical assessments are made, with greater reliability during the investigation stage of the project. Moreover, during project construction, particularly involving underground works, it becomes a challenging issue, at times, in effectively tackling adverse geological occurrences once faced, which demands a pragmatic approach of judicious implementation of apt tools and techniques. It is perceived that, presently there is a wide gap between the practice followed and the state-of-the-art available. This gap needs to be bridged in ensuring timely completion of a safe and economic project.

This book titled, *"Advanced Tools & Techniques for Efficient Project Development"*, forms the first part of the Water Resources publication series on: Hydroelectric & Pumped Storage Project Development. The objective of the publication is to bring out the best practices and a selection of prime advanced tools & techniques, presently available, for enhancing efficiency of project investigation and construction. The forthcoming Part II & Part III publications in this series will be based on case studies related to 'geological surprises' and mitigation measures adopted.

Earlier in 2016, CBIP had undertaken a research project under Research Scheme on Power (RSoP) program of Central Power Research Institute (CPRI), Bangalore, titled, *"Compilation of Data on Latest Technologies in Geological & Geotechnical Investigations and Problems Faced & Mitigation Measures adopted during Execution"*. However, since then, there has been considerable development. Accordingly, it was felt necessary to bring out this publication, presenting the latest developments and the globally emerging technologies and furnishing updated information on the subject.

The book introduces to the readers the merits of the present-day state-of-the-art techniques and equipment that would be helpful in making realistic geological & geotechnical assessments with precision as well as in gaining knowledge about the advantages of application of the advanced methodologies and construction equipment. It intends to guide in selecting and gainfully utilizing the technologies, as considered appropriate by the project developers, in consideration of the relevance, applicability as well as the stage of project development - thereby enhancing the efficiency and level of confidence in execution of hydroelectric and pumped storage schemes, towards establishing safe and sustainable projects in time. Moreover, the information provided in this book shall be useful for those developers, as well, who are associated with construction of various underground spaces and execution of other civil engineering works.

Aditya

(Aditya K. Dinkar)

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