सत्यमेव जयते

Government of India
Ministry of Water Resources,
River Development and Ganga Rejuvenation
(http://mowr.gov.in)

CWPRS Annual Report 2014-15

CENTRAL WATER AND POWER RESEARCH STATION

KHADAKWASLA, PUNE-411024, INDIA

ANNUAL REPORT 2014-15

CENTRAL WATER AND POWER RESEARCH STATION, PUNE

VISION

To be a worldclass centre of excellence in research on hydraulic engineering and allied areas; which is responsive to changing global scenario, and need for sustaining and enhancing excellence in providing technological solutions for optimal and safe design of water resources structures.

MISSION

- ***To meet the country's need for basic & applied research in water resources, power sector and coastal engineering with world-class standards***

- ***To develop competence in deployment of latest technologies by networking with the top institutions globally, to meet the future needs for development of water resources projects in the country effectively***

- ***To disseminate information, build skills and knowledge for capacity-building and mass awareness for optimization of available water resources***

MAJOR FUNCTIONS

- ***Undertaking specific research studies relating to development of water resources, power and coastal projects***

- ***Consultancy and advisory services to Central and State Governments, private sector and other countries***

- ***Disseminating research findings and promoting/assisting research activities in other organizations concerned with water resources projects***

- ***Contributions to Bureau of Indian Standards and International Standards Organization***

- ***Carrying out basic and applied research to support the specific studies***

- ***Contribution towards advancements in technology through participation in various committees at National and State Levels***

MAIN HIGHLIGHTS/ ACHIEVEMENTS (2014-15)

A. UNDERTAKING SPECIFIC RESEARCH STUDIES RELATING TO DEVELOPMENT OF WATER RESOURCES, HYDRO POWER AND COASTAL PROJECTS

At any given time, on an average about 250 site specific studies are in progress at the research Station under the seven major disciplines namely viz., River Engineering, River and Reservoir Systems Modelling, Reservoir and Appurtenant Structures, Coastal and Offshore Engineering, Foundation and Structures, Applied Earth Sciences & Instrumentation, Calibration and testing of current meter and flow meter. A few important ones briefly described below;

1. Studies for Barapullah Elevated Road Bridge across Yamuna-Delhi

CWPRS studied the proposal to construct a road bridge across river Yamuna at Delhi, downstream of Nizamuddin road bridge on the existing mobile bed model of river Yamuna at Delhi, constructed to a horizontal scale of 1:300 and a vertical scale of 1:60 covering a river reach of 50 Km from Palla to Jaitpur. It was suggested to change the orientation of pier and increase the span to 42.5m. It was also assessed that the proposed bridge will not cause any major change in the river regime.

2. Studies for Neradi Barrage and Katragada Side Weir

CWPRS studied the back water and submergence issues related to construction of a barrage across river Vamshadhara at Neradi village of Srikakulam district in Andhra Pradesh to cater for the irrigation. The issue was also before the Vanshdhara Water Disputes Tribunal (VWDT). The VWDT visited the model in CWPRS twice to understand the various intricacies involved in the dispute. Based on the CWPRS reports and discussions, VWDT has cleared the construction of Katragada side weir. CWPRS is further supporting VWDT in resolving issues related to Neradi barrage for which they visited CWPRS in the month of December 2014.

3. Mathematical Model Studies for Backwater Effect of Dr. Ambedkar Pranahita Barrage - Chevella, Telangana

CWPRS carried out 1-D hydraulic flood routing model HEC-RAS (steady state) to study the backwater effect of barrage for different flood events (observed and for 25-yr, 50-yr, 100-yr return period events). Highest Water Levels (HWL) at the locations of interest in project area were extracted from model results. Effect of lowering of barrage height on the flood levels and resulting change in storage capacity of project was also studied. CWPRS studies have helped both Telangana & Maharashtra Governments Technical committees arriving at general consensus on the inundation levels in the fringe villages of the banks and finalization of Full Reservoir Levels (FRL).

4. Hydraulic Model Studies for Power Intake of Punatsangchhu-I H.E. Project, Bhutan

Hydraulic model studies were conducted in a 1:35 geometrically similar scale model to study performance of power intakes. Studies were conducted on two alternative designs of pier nose and the design with occasional surface swirls has been recommended. It was observed that no air-entraining vortices occurred for all operating conditions. Therefore, the submergence provided at intake was found to be adequate and anti-vortex devices were not required.

5. Hydraulic Model Studies for Dri Dam Spillway, Etalin H. E. Project, Arunachal Pradesh

Hydraulic model studies were conducted on 1:40 scale 2-D sectional model and 1:60 scale 3-D comprehensive model for finalizing the hydraulic efficient design of spillway and energy dissipator. The model studies were conducted for discharging capacity of spillway, pressure over spillway surface, water surface profile and performance of energy dissipater. It is suggested to provide intermediate piers to be tapered suitably and/or extended up to the lip of the ski jump bucket for minimizing/ eliminating the rooster tails and the spray generated. It is also suggested to provide aerator or operate the reservoir at MDDL for minimizing the cavitation over the spillway surface. The performance of ski jump bucket type energy dissipater was found to be satisfactory.

6. Proposed Nuclear Power Project at Mithivirdi, Gujarat and PFBR at Kalpakkam, Tamilnadu

The comprehensive studies carried out by CWPRS for dispersion of the warm water discharge as well as mathematical model studies carried out for hydrodynamics and sedimentation aspects, enabled NPCIL to design the important components of the Nuclear Power Plant. Furthermore, these studies carried out by CWPRS helped M/S NPCIL to obtain CRZ Clearance in principle from the Ministry of Environment and Forest. Furthermore a detailed note on the impact of vibration and noise on marine life during construction of outfall structure for the Power Plant was also submitted by CWPRS.

Similar studies were carried out for the Fast Breeder Reactor Project (PFBR) at Kalpakkam.

7. Mathematical Model Studies for Improvement of Draft in Hugli Estuary

CWPRS has been associated in undertaking mathematical model studies to find suitable mitigation measures to reduce the maintenance dredging and improve the draft. In this regard a long term solution of creating alternative navigation channel by cutting an artificial channel across the Nayachara Island has been successfully taken up by CWPRS and a feasible cut has been recommended.

8. Hydraulic Model Studies for 2nd stage development of Karwar port, Karnataka

The wave tranquillity aspects for 2nd stage development for Karwar Port, Karnataka were studied at CWPRS using the physical model with Geometric Similar (G.S.) scale of 1:120. In order to improve the wave tranquillity at the exposed berths, it was considered to shift the port entrance to northwest direction. The suggested configuration in modified layout would consist of new northern breakwater of length reduced to 1035m and existing western breakwater will be extended upto 750m with port entrance oriented in the northwest direction.

9. Protection to the Gas Pipeline at Hazira, Gujarat

CWPRS suggested emergency protection works in the form of a offshore bund in the form of sand filled, geo-textile bags in front of the exposed gas pipeline at Hazira, Gujarat. Furthermore, a permanent solution of re-routing the pipeline and a permanent offshore bund was also suggested by CWPRS to provide protection against erosion for the proposed re-route of the pipeline as well as the existing 36″ and 42″ pipelines.

B. TRAINING AND DISSEMINATING RESEARCH FINDINGS

Training Programmes attended	-	62 Nos.
Training Programmes organized	-	09 Nos.
Reports Submitted	-	113 Nos.
Paper Published (Journals/ Conferences)	-	62 Nos.

CONTENTS

FROM THE DIRECTOR'S DESK

At the outset, it gives me immense pleasure in presenting the Annual Report for the year 2014-15, highlighting the activities and achievements of Central Water & Power Research Station.

As a premier hydraulic research institute in the country, CWPRS continues to provide R&D and consultancy support to a variety of projects using physical hydraulic models, mathematical models and field and laboratory experiments. With the expertise of seven major civil engineering disciplines under one umbrella, CWPRS has distinct advantage in providing single window solutions to problems involving multiple disciplines.

CWPRS dedication to organisational excellence is vital to its success and growth. From its inception in the year 1916, CWPRS has been unstintingly working to establish an impetus for improvements in the integrated basic, applied & result-oriented research and development programs, for achieving greater competence and efficacy. To guide its ongoing journey of excellence, CWPRS institutes in-depth relations with its clientele, by learning their environments & challenges, to enable it to offer tangible solutions with a sincere perspective.

I take this opportunity to appreciate the scientists, engineers and employees of CWPRS, not only for their extensive knowledge and professionalism but also for their resolute commitment which has always made us stand out to our clientele. I am sure we would keep working to deliver high-quality sustainable solutions with the spirit of uniqueness that we are known for, in order to continue being the world's premier hydraulic research institute.

The present report provides an insight into the functions and activities of this organization and its contribution in the development and management of water resources, river training works, hydroelectric/ thermal/ nuclear power, and design of coastal and offshore engineering structures and port layouts.

During 2014-15, more than 113 applied research projects were completed in the areas of seven major disciplines of CWPRS. Under Instrumentation, Calibration and Testing facilities, various types of current meters have been calibrated. A number of studies were conducted for various clients with the available gravimetric and volumetric calibration facilities.

Dissemination of knowledge & research findings through research papers, participating in technical events, imparting training programs on specialized topics and delivering invited lectures at different organizations is a significant mandate of CWPRS. Glimpses of these institutional activities may be seen in the report.

As is the case every year, the institution had a galaxy of visitors during 2014-15. Use of official language Hindi is pursued and encouraged resolutely on a day-to-day basis. Hindi Pakhwada was organised at CWPRS to encourage accelerated use of Hindi in official communications. Hindi day was celebrated on 14th September 2014.

I hope the report would provide the nuclear glimpses of activities of CWPRS.

Date: 30th May, 2016 **Dr. M.K. SINHA**

ABOUT THE INSTITUTE

General

The Central Water and Power Research Station (CWPRS), Pune, established in 1916 by the then Bombay Presidency as a Special Irrigation District, is the leading national hydraulic research institute under the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD&GR), New Delhi. In its early days of formation, this institute played important role conducting outstanding research work for the Sukkar Barrage in Sind, the largest irrigation project in the world (1927 to 1932). Recognizing its role in the systematic study of various phases of water flow, including floods, the institution was taken over by the then Government of India in 1936. With the dawn of independence, and launching of planned development of water resources of the nation, CWPRS became the principal central agency to cater to the research and development (R&D) needs of hydraulics and allied disciplines for evolving safe and economical designs of hydraulic structures involved in water resources projects, river engineering, power generation and coastal engineering projects. The research activities at CWPRS can be grouped into seven major disciplines as listed below.

- River Engineering
- River and Reservoir Systems Modelling
- Reservoir and Appurtenant Structures
- Coastal and Offshore Engineering
- Foundation and Structures
- Applied Earth Sciences
- Instrumentation, Calibration and Testing Facilities

Advisory services are offered to the government within the sphere of its activities by participation in various expert committees. The solutions offered by CWPRS are based on the investigations from physical and mathematical models, field investigations coupled with desk studies or from a combination of these. The institution also carries out collection and analysis of field/ prototype data on a variety of engineering, hydraulic and environmental parameters. Disseminating the research findings amongst hydraulic research fraternity, and promoting research activities at other institutions by imparting training to their research manpower, are also undertaken.

Today, as a part of the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD&GR), the mandate of the institution encompasses undertaking specific research studies supported by necessary basic research. Comprehensive R&D support is offered to a variety of projects in fields as diverse as river training and bank protection measures, hydraulic design of bridges and barrages, flood forecasting, dam break analysis, water quality analysis of river and reservoir systems, design of spillways and energy dissipators, analysis of water conductor and tail race system, optimization of the design and layout of ports and harbours suggesting coastal protection measures based on locally available materials, investigations for foundations of hydraulic structures, analysis of structures subjected to various static and dynamic loads, applied earth sciences studies for the sites of hydro-electric and other projects, calibration of currentmeters and flow meters, testing of pumps and turbines and instrumentation for dams.

CWPRS campus, situated downstream of Khadakwasla dam in south westerly part of Pune, occupies an area of about 400 acres, where major research infrastructure available include: water re-circulation system for physical models, workshop, library, computers and communication facilities, auditorium and housing facilities. CWPRS has been recognized as the regional laboratory of the Economic and Social Commission for Asia and the Pacific (ESCAP) since 1971. The institution, with multi-disciplinary approach in its activities, thus represents unique services available to the country and the ESCAP region.

Organizational Set-up

CWPRS is a subordinate office of MoWR, RD&GR. The Director is the Head of the Organization designated as Head of the Department. Scientist-E is the group leader of the discipline of research. The Chief Administrative Officer is designated as the Head of Office. The total sanctioned staff strength of CWPRS is 1,131. The research cadre, comprising of Director, Additional Director, Scientist-E, Scientist-D, Scientist-C, Scientist-B, Assistant Research Officer (ARO) and Research Assistant (RA) has a sanctioned strength of 337 personnel. The other supporting staff includes technical, auxiliary technical, administration, accounts and ancillary services. The Governing Council (GC), under the Chairmanship of the Secretary, MoWR, and the Technical Advisory Committee (TAC) under the Chairmanship of the Chairman, Central Water Commission render advice to the Ministry regarding functioning of CWPRS.

Governing Council

The GC functions as an overall policy making body for CWPRS under the Chairmanship of the Secretary, MoWR, RD&GR. The GC comprises members from the Finance and Administrative Wings of MoWR, Planning Commission, User Organizations, State Governments and Non-Government Officials. Apart from laying down broad policy guidelines, the GC monitors the overall progress and performance of the institution. Other functions of GC include scrutiny and monitoring of expansion programmes, annual and five-year plans, budgetary allocations, creation and abolition of work disciplines, review of manpower requirements and delegation of additional powers.

Technical Advisory Committee

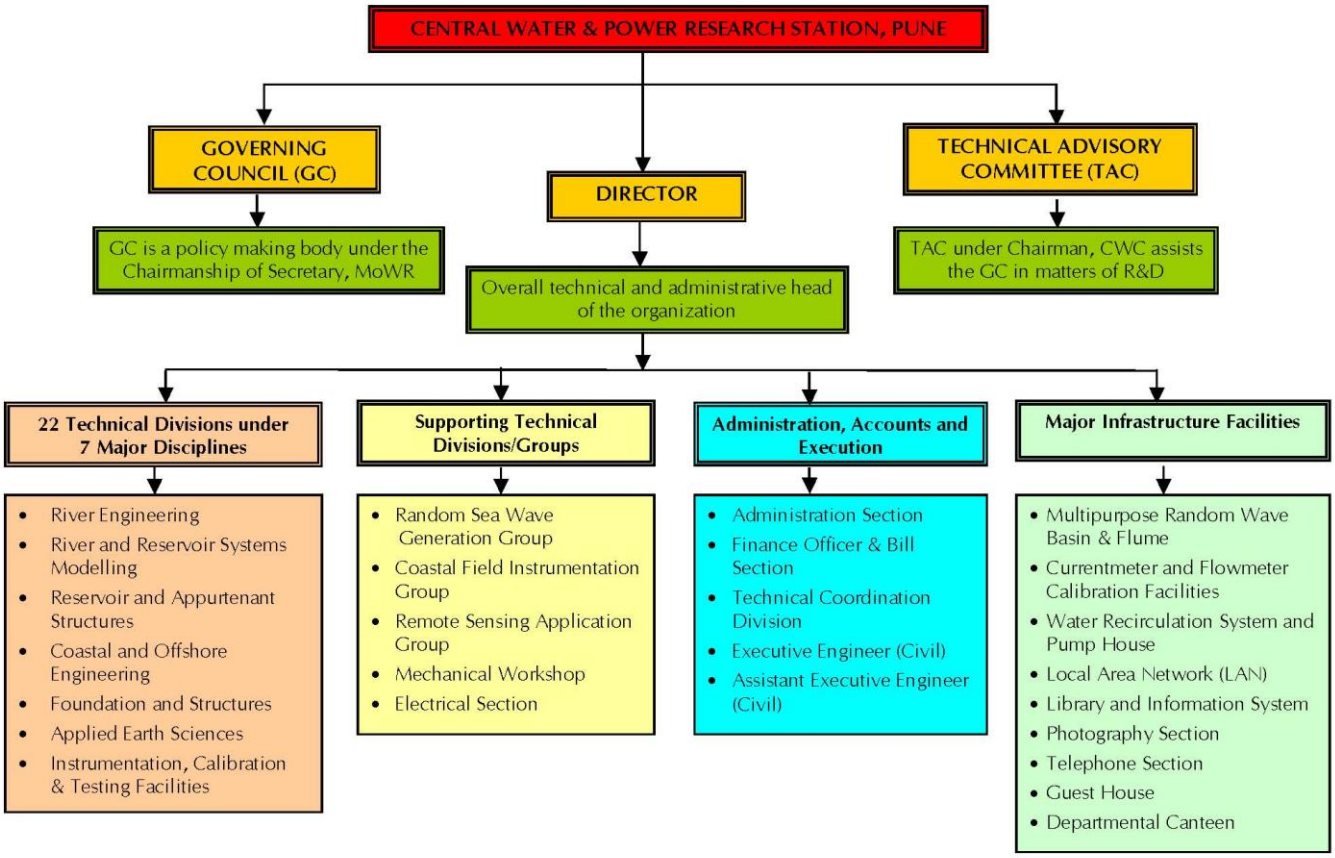
The TAC, chaired by the Chairman, Central Water Commission, is primarily intended to assist the GC in the matters of R&D and associated technical programmes. The Committee, inter alia, scrutinizes and recommends the expansion and research proposals under the five-year plans, suggests programmes for training of manpower and provides guidance in formulation of collaborative arrangements and Memoranda of Understanding with other agencies/ institutions.

Budget and Programme Committee

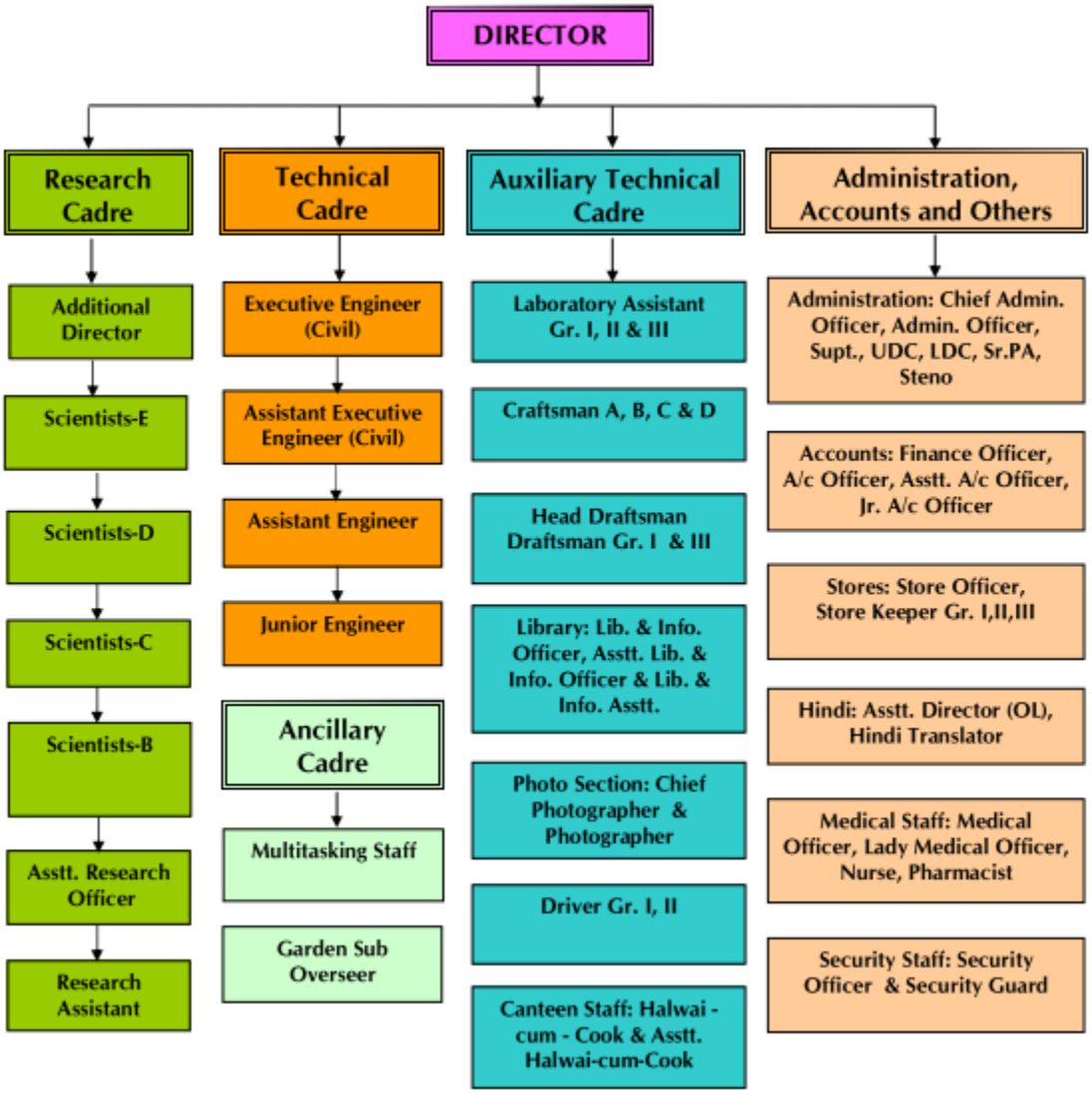
The Budget and Programme Committee (BPC) assists the GC in formulation of budget proposals. The terms of reference of the Committee include: monitoring progress in implementation of the approved programmes and utilisation of the sanctioned budget, and linking programmes and budget closely so as to facilitate preparation of a proper performance budget. The Director, CWPRS, is the chairperson of the BPC; with the Finance Officer being the Member Secretary.

PART-I
GENERAL

ORGANIZATIONAL SETUP



ORGANIZATIONAL CHART



BUDGET AND FINANCE

1. Plan Schemes

The main purpose of Plan Schemes is to develop and strengthen the research infrastructure at CWPRS for serving the nation through research more efficiently and effectively. The following scheme was under implementation at the institution during 2014-15.

Name of the scheme	Final Estimate 2014-15
XIIth Plan - R&D in Apex Organizations under MoWR– CWPRS component	9.00 crore

During 2014-15, the following important activities were undertaken under the above-mentioned schemes.

R&D in Water Sector, Ministry of Water Resources, River Development and Ganga Rejuvenation - R&D in apex organizations – CWPRS component

Objectives: Under XIIth Plan scheme "R&D Programmes in Water Sector", CWPRS has mainly aimed at strengthening and modernization of its laboratories, instruments, and infrastructure facilities. Other major items include ICT, Training and Dissemination, Basic Research and Mathematical Modelling Software.

Activities: During 2014-15, with a budget outlay of Rs 9.00 Crore, the major activities undertaken included.

Establishment: (Training & Basic Research) (Rs.10.45 Lakh)

Infrastructure: For development of Tidal Basin facility for Estuarine & Tidal hydrodynamic studies by renovation of existing hangar (Rs.0.45 Crore), Development of experimental facility for studying the Spillways & Energy Dissipators (Rs.0.059 Crore), Renovation of various office-cum-laboratory buildings, boundary wall, roads, special repairs to residential and office buildings and horticulture works etc (Rs.2.13 Crore)

Stores & Machinery: for stores & machinery containing Procurement of Digital Gauges to measure water level (0.063 Cr.), Procurement of Water Heater System for simulation of thermal discharges (0.265 Cr.), Procurement of i) Software for Remote sensing/GIS ii) Workstation for Remote sensing/GIS (0.45 Cr.), Batteries and cables of specifications for Ground Penetrating Radar system (0.04 Cr.), Mathematical Modelling Software-Procurement of software's LITPCK, MIKE21 (0.223 Crore), Procurement of filter assembly (0.004 Cr.), Procurement of LAN switches and software.(0.282 Cr.), Geotechnical Permeameter (0.010 Cr.), Procurement of CFD software FLOW3D (advanced training and one year AMC of software) (0.014 Cr.)

Operating Cost: Expenses for operating cost for Electrical usage charges, expenses towards domestic/ foreign travel, security of office/ staff colony premises, outsourcing of security and house-keeping tasks etc (1.19 Crore)

2. Non-Plan Budget

The non-plan budget and expenditure details for the year 2014-15 are given below.

Item/ Head	2014-15 (₹ Crore)		
	Budget Estimate	Revised Estimate	Actual
Salary	51.75	52.50	51.39
Non-Salary	2.86	2.71	2.68
Total (Gross)	54.61	55.21	54.07
Recovery	6.50	9.10	11.95
Net	48.11	46.11	42.12

STAFF WELFARE ACTIVITIES

1. Minority Welfare

The recruitment of personnel from minority community, and representation of minorities in Selection Committees/ Boards is monitored in accordance with guidelines issued by the erstwhile Ministry of Welfare (present Ministry of Social Justice & Empowerment) in March 1990.

2. Monitoring of Reservation for Physically Handicapped

Monitoring of Reservation for Physically handicapped persons is monitored to ensure fulfillment of three percent quota as stipulated. At present, a total 31 persons with disabilities are working in the Research Station with 2, 4 and 25 in group A, B, C respectively. Benefits earmarked like Transport Allowance, Concessions regarding Recruitment fees, Professional Tax exemptions etc. are provided as per Government instructions. Slope ladders and special washrooms are being provided in Research Station wherever possible.

Group	Position as on 31 st March 2015
	PH
A	02
B	04
C	25
Total	31

3. Monitoring of Reservation for SC/ ST/ OBC

Monitoring of the recruitment of candidates from SC/ST/OBC category is monitored by following the guidelines issued from time to time. Shri. T. Nagendra. Scientist E guides the overall matters in this regard as Liaison Officer. A summary of posts filled from SC/ST/OBC categories are given below.

Group	Position as on 31 st March 2015			
	SC	ST	OBC	UR
A	34	09	23	112
B	28	05	25	127
C	82	40	48	273
Total	144	54	96	512

4. Preservation and Enforcement of Right to Gender Equality of Working Women

There are five-members in the committee for preservation and enforcement of right to gender equality of working women; with the composition of the committee as per the guidelines issued by the Honourable Supreme Court of India. Dr. (Mrs.) V V Bhosekar, Scientist-E is the Chairperson of the committee. Meetings of the committee are held regularly. No complaints were received during 2014-15.

5. CWPRS Staff Colony Welfare and Recreation Club Activities

The CWPRS Recreation Club has been constituted to provide facilities for the staff members to promote social, recreational and friendly relations amongst its members to foster unity and fellow feelings to provide facilities for physical, cultural, intellectual and recreational and other activities that are open to all the members from time to time. All the employees of the CWPRS are eligible to become members of the club on their own by

paying annual subscription of Rs. 25/-. Every year the Recreation Club provides cultural and recreational activities to the members by arranging excursion trip in and around Pune, sports, lectures and other activities throughout the year. Health is Wealth. Keeping this in mind, the CWPRS Recreation Club had arranged following programs:

- Yoga Shibir was conducted on 10 & 11 December 2014.
- A dental Check-up Camp was organized at CWPRS on 10.03.2015. Nearly 220 persons (officers and staff members) took advantage of the camp.
- Lecture on `Stress Management' by Dr. Rajendra Kalaskar, on 25.3.2015
- Swine Flu Vaccination Programme for members and their families on 22-4-2015

The above programs received overwhelming response from CWPRS officers and staff members. A Bhondla and Rangoli competition was organized on 30-9-2014 for lady members. The Recreation Club had arranged `Til Gul Samaramb' on 23.1.2015 on the occasion of Makara Sankranti to bring all the employees together. The Club organized various in-house sports for its members during February 2015. Ladies and Gents participated in large numbers and won prizes. The Club had also actively participated in the Shiv Jayanti Programme organized by the Kamgar Sabha at CWPRS. Keeping in view the reading interest of its members, the Recreation Club made available to its readers from the CWPRS Recreation Club Library for the year 2014-15.

As a part of the concluding activity of CWPRS Recreation Club an Annual Day function by the Recreation Club was organized in June 2015. A Musical Orchestra was arranged on account of Annual Day. Prizes were distributed to the winners of the various sports and cultural events organized by the Recreation Club for the year 2014-15 at the hands of the Chairman, Recreation Club.

VIGILANCE AND DISCIPLINARY CASES

The vigilance / disciplinary cases, and related complaints concerning officers and staff of CWPRS, received prompt attention during 2014-15. Break-up of vigilance and disciplinary cases in respect of different categories of staff, as on 31st Mar 2015, is given below in Tables I and II respectively.

Table I: Vigilance cases

No.	Particulars	Group A & B	Group C
1	No. of cases pending in the beginning of the year	6	0
2	No. of cases added during the year	0	0
3	No. of cases disposed off during the year	0	0
4	No. of cases pending at the end of the year	6	0

Table II: Disciplinary cases where the Director, CWPRS is the disciplinary authority

No.	Particulars	Group A	Group B	Group C
1	No. of cases pending in the beginning of the year	NA	0	0
2	No. of cases added during the year	NA	0	0
3	No. of cases disposed off during the year	NA	0	0
4	No. of cases pending at the end of the year.	NA	0	0

RTI ACT, GRIEVANCE REDRESSAL MECHANISM AND CITIZEN'S CHARTER

1. RTI Act

Under the provisions of Section 4 (b) of RTI Act 2005, a manual containing suo-moto information on CWPRS has been published in the Website www.cwprs.gov.in as a part of implementation of the act. The manual is periodically updated. Further, all efforts are being taken to administer and implement the act. The citizens are also given guidance in obtaining information under the act. The names, addresses, and other details regarding the Appellate Authority and Public Information Officer are given below.

Appellate Authority : S. Govindan, Director, CWPRS, Pune 411 024;
Tel. : 020-24380552

Public Information Officer : R.K. Kamble, Joint Director, CWPRS, Pune 411 024;
Tel.: 020-24103411 (Office); 020-24444375 (Residence)

Information on requests and appeals handled under the act during 2014-15 is summarized below.

	Opening balance as on 1/04/2014	Received during the month (including cases transferred to other Public Authority)	No. of cases transferred to other Public Authorities	Decisions where requests/ appeals rejected	Decisions where requests/ appeals accepted
Requests	4	43	0	0	36
First Appeals		8	0	0	8
Amount of Charges Collected (Rs)					
Registration fee amount	Additional fee & any other charges	Penalties amount			
240/-	10/-	Nil			

2. Grievance Redressal Mechanism

A Grievance Cell under the chairmanship of Shri T. Nagendra, Scientist E, functions with the objective of looking into the grievances and for their redressal. The relevant data pertaining to cases handled during 2014-15 is given below:

Grievance cases pending as on 31st March 2014	14
Cases received during 2014-15	25
Cases disposed off during the year	30
Cases pending on 31st March 2015	9

The Centralised Public Grievance Redress and Monitoring System (CPGRAMS), the web based portal that enables an Indian citizen to lodge a complaint from anywhere and anytime directly, has been implemented at CWPRS. Periodical updating of the entries are being carried out and relevant reports are submitted.

3. Citizen's Charter

The Citizen's Charter in respect of CWPRS, formulated by a Task Force specially constituted for the purpose, has been subsequently upgraded/ revised/ modified in pursuance of related instructions/ communications from the Ministry from time to time, including the 7-step model for `Sevottam for Citizen Centricity in Administration' as per relevant instructions of DARPG. The main components of the Citizen's Charter include: Vision and mission statement, details of business transacted and customers/ clients, service provided by the organization, details of grievances redressal mechanism in place and expectations from clients. Presently the Charter is in the process of getting formal approval from MoWR, RD&GR.

IMPORTANT VISITORS

Visit of Hon'ble Minister Shri Vijay Kumar Chaudhary
19th September 2014

Visit of Shri K.M.M. Alimalmigothi, Economic Advisor
15th January 2015

Visit of Dr. Amita Prasad, Joint Secretary (Admn & GW)
28th March 2015

IMPORTANT EVENTS

Training course on Canal Automation
21st May2014

Training course on Coastal Erosion and Protection
18th June 2014

Lecture by Shri Ramesh Chandra, Chief Technical Examiner, Central Vigilance Commission
11th August 2014

Hindi Divas Samaroh
14th November 2014

Swachh Bharat Abhiyan
2nd October 2014

Foundation Stone Laying ceremony of hangar for Coastal Engineering
5th March 2015

Foundation Stone Laying ceremony of hangar for River Engineering
5th March 2015

राजभाषा हिन्दी के प्रगामी प्रयोग से संबंधित प्रमुख गतिविधियाँ

इस अनुसंधान शाला में कार्यालयीन कामकाज में हिन्दी के प्रगामी प्रयोग से संबंधित गतिविधियों के बारे में निम्नानुसार जानकारी प्रस्तुत है :

हिन्दी दिवस तथा हिंदी पखवाड़ा

अनुसंधान शाला में 14 सितम्बर 2014 को हिंदी दिवस मनाया गया । इस अवसर पर मुख्य अतिथि अनुसंधान शाला के निदेशक श्री एस गोविन्दन थे । प्रति वर्ष की भांति इस वर्ष भी हिंदी पखवाड़े के दौरान राजभाषा कार्यान्वयन समिति के मार्गदर्शन में हिंदी निबंध, वादविवाद, वार्तालाप, प्रश्नमंच, हिन्दी श्लोगन, हिंदी अंताक्षरी तथा तकनीकी कार्य में हिंदी का प्रयोग आदि प्रतियोगिताओं का आयोजन किया गया । इन प्रतियोगिताओं में संस्था के अधिकारियों एवं कर्मचारियों ने उत्साह से भाग लिया । भारत सरकार द्वारा लागू मूल रूप में हिंदी टिप्पण आलेखन पुरस्कार योजना अनुसंधान शाला में लागू की गई थी । इन प्रतियोगिताओं में योग्यता प्राप्त अधिकारी एवं कर्मचारियों को मुख्य अतिथि के करकमलों द्वारा नकद पुरस्कार एवं प्रमाणपत्र देकर प्रोत्साहित किया गया ।

हिन्दी पत्रिका जलवाणी का प्रकाशन

हिंदी दिवस के अवसर पर निदेशक महोदय के करकमलों द्वारा अनुसंधान शाला की हिंदी गृह पत्रिका जलवाणी के इक्कीसवें अंक का विमोचन किया गया । अनुसंधान शाला के अधिकारियों एवं कर्मचारियों ने उक्त पत्रिका में विभिन्न विषयों पर लेख लिखकर अपना योगदान दिया है ।

हिन्दी कार्यशाला का आयोजन

वार्षिक कार्यक्रम में दिए गए निर्देशों के अनुसार अनुसंधान शाला में निम्नांकित तारीखों को हिन्दी कार्यशालाएँ आयोजित की गई :

अ.क्र.	अवधि	श्रेणी	अधिकारियों संख्या
1	24.6.2014	अनुसंधान सहायक 19	19
2	12.11.2014	आशुलिपिक 16	16
3	11.3.2015	अनुसंधान अधिकारी 26	26

अनुसंधान शाला के सभी संगणकों में हिन्दी सॉफ्टवेयर लगवाए गए हैं जैसे iLeap, ISM Office, ISM Publisher और iTranslator इत्यादि । यूनिकोड आधारित सॉफ्टवेयर ISM V6 नेट वर्ज़न खरीद कर प्रयोग में लाया जा रहा है ।

प्रशिक्षण कार्यक्रम में संघ की राजभाषा नीति, सरकारी पत्राचार के नमूने, टिप्पण आलेखन एवं भाषा और वर्तनी के बारे में उपयोगी सामग्री उपलब्ध कराई गई । उपस्थित सभी प्रतिभागियों को कार्यशाला पुस्तिका भी वितरित की गई, जिसमें कार्यालयीन उपयोग से संबंधित जानकारी जैसे वाक्यांश, पदनाम, नेमी किस्म के पत्रों के नमूने, छुट्टी के आवेदन आदि सम्मिलित हैं । उपस्थित प्रतिभागियों ने कार्यशाला की उपयुक्तता के बारे में अपनी अनुक्रियाएँ (फीड बैक) प्रस्तुत की ।

कंप्यूटरों में हिंदी साफ्टवेयर

अनुसंधान शाला के सभी संगणकों में हिन्दी सॉफ्टवेयर लगवाए गए हैं जैसे iLeap, ISM Office, ISM Publisher और iTranslator इत्यादि । इस वर्ष यूनिकोड आधारित सॉफ्टवेयर ISM V6 नेट वर्ज़न खरीद कर प्रयोग में लाया जा रहा है । साथ ही गुगल आधारित यूनिकोड सॉफ्टवेयर का प्रयोग भी किया जा रहा है ।

वेबसाइट

इस अनुसंधान शाला की वेबसाइट www.cwprs.gov.in बनाई गई है जिसमें संस्था के बारे में जानकारी हिंदी में उपलब्ध कराई गई है। इसका समय समय पर अद्यतन किया जाता है।

अनुसंधान शाला के इन्ट्रानेट पर हिन्दी में नेमी प्रपत्र /मानक मसौदे उपलब्ध कराना

प्रतिदिन काम आनेवाले नेमी किस्म के प्रपत्र, मानक मसौदे जैसे आकस्मिक छुट्टी के आवेदन, कार्यग्रहण रिपोर्ट, प्रस्थान रिपोर्ट, प्रभागों/अनुभागों के नाम, मंत्रालयों/विभागों के नाम, छुट्टियों के प्रकार, वर्तनी, संदेश, गृह पत्रिका जलवाणी का इक्कीसवाँ अंक, हमेशा प्रयुक्त होने वाले वाक्यांश आदि इन्ट्रानेट पर हिन्दी में उपलब्ध कराए गए हैं। साथ ही अनुसंधान शाला द्वारा सभी प्रयोगशालाओं की तकनीकी शब्दावली उपलब्ध कराई गई।

हिन्दी में कार्य के लिए अनुभागों का नामांकन

निम्नांकित प्रभागों / अनुभागों में कार्य की कुछ मदें हिन्दी में करने के लिए विनिर्दिष्ट की गई है

अ.क्र.	प्रभाग अनुभाग /	प्रभाग द्वारा किए जाने वाले कार्य
1.	प्रशासन	• समूह के कर्मचारियों की "ग" और "ख" "क" सेवा पुस्तिकाओं में प्रविष्टियां • छुट्टियों के कार्यालय आदेश • आवधिक वेतन वृद्धि के प्रमाणपत्र • छुट्टी यात्रा रियायत अग्रिम का आदेश • वेतन नियतन के कार्यालय आदेश • सेवा निवृत्ति के आदेश • कर्मचारियों की वरिष्ठता सूची • आवास आबंटन की अग्रता सूची • दौरा अग्रिम के आदेश • कुछ फाइलों में टिप्पण आलेखन
2.	प्रशासन नियमित)औद्योगिक स्थापना	• कर्मचारियों की सेवा पुस्तिकाओं में प्रविष्टियां • छुट्टियों के कार्यालय आदेश • आवधिक वेतन वृद्धि के प्रमाणपत्र • कर्मचारियों को ज्ञापन • छुट्टी यात्रा रियायत अग्रिम का आदेश • वेतन नियतन के कार्यालय आदेश • सेवा निवृत्ति के आदेश • कर्मचारियों की वरिष्ठता सूची • कुछ फाइलों में टिप्पण आलेखन
3.	बिल अनुभाग	• द्विभाषी वेतन पर्ची • चिकित्सा अग्रिम के आदेश • चिकित्सा अग्रिम से संबंधित जाँच सूची

		• दौरा अग्रिम के आदेश
4.	अधिशासी अभियंता का कार्यालय (सिविल)	• बेबाकी प्रमाण पत्र • चेकों के अग्रेषण पत्र • प्राप्त हुए भुगतान की पावती
5.	तटीय इंजीनियरिंग के लिए गणितीय प्रतिमानन (संगणक)	• तकनीकी रिपोर्टों के सारांश तथा अन्य कार्यों में यथा संभव हिन्दी का प्रयोग किया जाता है।
6.	नदी जलगति विज्ञान	• तकनीकी रिपोर्टों के सारांश तथा अन्य कार्यों में यथा संभव हिन्दी का प्रयोग किया जाता है। • जलवाणी में लेख लिखकर कर्मचारियों का योगदान
7.	जल गुणवत्ता विश्लेषण तथा प्रतिमानन	• तकनीकी रिपोर्टों के सारांश तथा अन्य कार्यों में यथा संभव हिन्दी का प्रयोग किया जाता है।

नियम 8(4) के अधीन हिन्दी में कामकाज

अनुसंधान शाला के 10 अधिकारियों कर्मचारियों को राजभाषा नियम/1976 के नियम 8(4) के अधीन टिप्पण प्रारूपण और ऐसे अन्य शासकीय प्रयोजनों के लिए केवल हिन्दी का प्रयोग करने के लिए दिनांक 14.8.2003 के आदेश संख्या 675/6/2003-हिन्दी द्वारा नामित किया गया है।

तकनीकी काम में हिन्दी का प्रयोग

अनुसंधान शाला के विभिन्न प्रभागों/अनुभागों द्वारा किए जाने वाले अध्ययनों के आधार पर परियोजना प्राधिकारियों को भेजे जाने वाली तकनीकी रिपोर्टो के सारांश, अग्रेषण पत्र, रिपोर्ट प्रलेख पत्र, सार, प्राक्कलन, विषय सूची आदि मदें अंग्रेजी के साथ अनिवार्यत भेजने हेतु अनुरोध किया गया है।

संगोष्ठी का आयोजन

मंत्रालय के दिनांक 15 मई 2014 के पत्रांक 12019/82/2014/रा.भा. (का-2) द्वारा सूचित किया गया था कि केन्द्र सरकार के अधिकारियों/कर्मचारियों में हिन्दी के प्रति चेतना बढ़ाने हेतु कार्यालयों में हर तिमाही में हिन्दी संगोष्ठी का आयोजन किया जाए। तद्नुसार केन्द्रीय जल और विद्युत अनुसंधान शाला में चार हिन्दी संगोष्ठी का आयोजन किया गया। आयोजन से संबंधित रिपोर्ट मंत्रालय को भेजी गई।

PART-II
RESEARCH AND DEVELOPMENT

BACKGROUND

CWPRS is mainly engaged in project specific research to evolve safe and cost-effective designs of hydraulic structures involved in development of water resources, river engineering, power plants, and coastal engineering projects. Physical and mathematical model studies coupled with field and laboratory experiments are carried out for this purpose in the seven major areas of expertise of CWPRS as follows :

1. River Engineering: River Engineering mainly deals with river training and bank protection works, hydraulic design of barrages and bridges, and location and design of water intakes using morphological studies. Field studies for measuring water and sediment discharge in rivers and canals are also conducted.

2. River and Reservoir Systems Modelling: Hydrologic and meteorologic studies are conducted to estimate extreme values of various parameters such as rainfall, temperature and humidity. Flood estimation and forecast, reservoir sedimentation and water quality studies are carried out using mathematical models and field surveys.

3. Reservoir and Appurtenant Structures: Spillways and Energy Dissipators are studied on physical models. Water conductor systems including head race and tail race channels/tunnels and surge shafts are studied on both physical and mathematical models. Studies are carried out on physical models for desilting basins, sedimentation and flushing through reservoirs, sediment exclusion devices. Sedimentation in reservoirs is also assessed through remote sensing.

4. Coastal and Offshore Engineering: This discipline deals with optimization of location, length and alignment of breakwaters, jetties, berths, approach channel, turning circle etc. for development of ports and harbours. Estimation of siltation in harbours, their disposal and sand bypassing, location of sand trap and hot water recirculation studies are carried out using both physical and mathematical models. Suggesting suitable coastal protection measures based on locally available materials is an important activity of the group.

5. Foundation and Structures: Laboratory and field tests are carried out to determine soil, rock and concrete properties. Mathematical modelling as well as experimental studies are conducted for studying the stability and structural safety of dams and appurtenant structures. Field studies are carried out for assessing the health of hydraulic structures and suggesting suitable repairing measures.

6. Applied Earth Sciences: Seismic surveillance of river-valley projects, assessment of site-specific design seismic parameters, controlled blasting studies for civil engineering construction sites, evaluation of quality of concrete and masonry is done by non-destructive methods and estimation of elastic properties for foundation of massive structures for geophysical methods are the main activities of this group.

7. Instrumentation, Calibration and Testing Facilities: Hydraulic Instrumentation is used for data collection on physical hydraulic models. Field data collection is carried out on coastal parameters like water level, velocity, wave-height etc. A Random Sea Wave Generation (RSWG) system is used for wave flumes and basins. Dam instrumentation is provided on prototype. Current meter and flow meter calibration facilities are also available, which are used extensively.

This section first gives the list of 113 technical reports submitted during the year, and then presents the summaries of the studies carried out in the above seven disciplines.

LIST OF TECHNICAL REPORTS SUBMITTED

Sl.No.	TR No.	Date	Title
1.	5170	04/2014	Estimation of suitable placement temperature for mass concrete mix for Bham dam, Maharashtra
2.	5171	04/2014	Desk studies for the design of coastal protection work of Shrivardhan, Dist. Raigad
3.	5172	04/2014	Hydraulic model studies for reservoir sedimentation and flushing Devsari HE Project, Uttarakhand
4.	5173	04/2014	Mathematical model studies for tidal hydrodynamics and sedimentation for the proposed development of training walls/ groynes in the mouth of Theronda Creek in Raigad, Maharashtra
5.	5174	04/2014	Area drainage studies for proposed power plant of RIL at Hazira
6.	5175	04/2014	Hydraulic model studies for assessment of scour downstream of Salma Dam Spillway, Afghanistan
7.	5176	04/2014	Desk studies for the design of coastal protection works for PFBR plant site at Kalpakkam, Tamil Nadu
8.	5177	04/2014	Morphological studies to assess the changes in plan form of river Ganga near intake of Kahalgaon 3TPP of NTPC, Bihar
9.	5178	05/2014	Efficiency tests on 2 x 4.5 mw turbine units at Veer Hydro Electric Project, Dist. Satara, Maharashtra
10.	5179	05/2014	3D Stress Analysis by FEM of Bay area of spillway gate No.1 Telengiri Dam, Odisha
11.	5180	05/2014	Wave tranquility studies for the proposed mega container terminal of Tekra near Tuna, Kandla Port
12.	5181	05/2014	Desk studies to assess the effect of development of coal berth 3 and 4 on the shoreline at Kamarajar Port, Ennore
13.	5182	06/2014	Extreme value analysis of meteorological data for Banswara Nuclear Power Project, Rajasthan
14.	5183	06/2014	Estimation of site specific seismic design parameters for Bansuraja Dam, M.P.
15.	5184	06/2014	Storm surge analysis for the proposed thermal power plant of RIL at Hazira, Gujarat
16.	5185	06/2014	Bank protection works for the proposed power plant of M/s Reliance Inductor Ltd. At Hazira, Gujarat
17.	5186	06/2014	Storm measurement in penstock bifurcations 1 & 2 during prototype/ in-situ Hydrostatic test Teesta-III HE project, Sikkim
18.	5187	06/2014	Hydraulic model studies for extended ski-jump bucket for spillway of subansiri lower dam, Arunachal Pradesh
19.	5188	06/2014	Physical model studies for the layout of the proposed offshore break-water at Paradip Port, Odisha
20.	5189	06/2014	Assessment of quality of colgrout masonry of Tarali Dam, Satara, Maharashtra
21.	5190	06/2014	Mathematical model studies for wave tranquility in the area of proposed RO-RO jetty at Jaitapur, Maharashtra
22.	5191	06/2014	Mathematical model studies for tidal hydrodynamics and sedimentation due to the proposed RO-RO jetty at Jaitapur for NPCIL, Mumbai

23.	5192	06/2014	Monitoring of blast vibrators during underwater blasting for Jawaharlal Nehru Port, Navi Mumbai, Maharashtra
24.	5193	06/2014	Determination of safe grade elevator and area drainage studies for TPP of M/s NECL, Nellore (AP)
25.	5194	07/2014	Mathematical model studies for hydrodynamic and sediment transport for proposed port facilities at Sagar island in Hugli Estuary, West Bengal
26.	5195	07/2014	Hydraulic model studies extension of Barapallah elevated road across river Yamuna (Phase-III) from Sarai Kale Kham to Mayur Vihar at Delhi
27.	5196	07/2014	Mathematical model and desk studies for proposed flyover bridge across Mithi river upstream of Mini Confluence, Mumbai
28.	5197	07/2014	Desk studies for proposed Kharkai Barrage site near Ganjia village, Jharkhand
29.	5198	07/2014	Mathematical model studies for tidal hydrodynamics and siltation aspects for development of fisheries harbour at Manjeshwar, Kerala
30.	5199	08/2014	Studies for repair to spillway glacis and slotted roller bucket of Ichari dam, Uttarakhand
31.	5200	08/2014	Storm surge analysis for project Varsha in Andhra Pradesh
32.	5201	08/2014	Water availability studies at proposed barrage location in Gumani river for M/s Jindal Power Ltd.
33.	5202	08/2014	Studies on repair materials supplied by M/s Dimple Chemicals Service Pvt. Ltd., Pune for assessing their suitability in repairs and rehabilitation of hydraulic structures
34.	5203	08/2014	Mathematical model studies for flood protection works in Suketi Khad and its tributories, Himachal Pradesh
35.	5204	09/2014	Analysis and Interpretation of dam instrumentation data for period Jan 2013 - Dec 2013 for Non-Overflow block 25, Indira Sagar Dam
36.	5205	09/2014	Studies for repair of distressed transverse beam between column 1 and IA of Unit No.6 of Captive Power Plant No. I of Rourkela Steel Plant, Odisha
37.	5206	09/2014	Mathematical model studies to examine dispersion of effluent discharge at outfall located near proposed port of M/s JSW at Nandgaon, MH
38.	5207	09/2014	MMS for backwater effect of proposed modelling system barrage of Dr.B.R.A. Pranahita - Chivella Sujata Sravanthi Project, Telengana
39.	5208	09/2014	Estimation of site-specific seismic design ground motion for Loktak downstream hydro-electric project, Manipur
40.	5209	09/2014	Hydraulic model studies for desilting chamber for Mangdechhu HE Project, Bhutan
41.	5210	09/2014	Mathematical model studies for the assessment of wave tranquility for project Varsha, Andhra Pradesh
42.	5211	09/2014	Nuclear density logging and tracer studies for delineating path of seepage of Dimbhe masonry dam, Pune
43.	5212	09/2014	Extreme value analysis of meteorological data for Bhimpur Nuclear Power Project, M.P.
44.	5213	09/2014	Mathematical model studies for flood management of river Pabbar in Tehsil Rohra, Dist. Shimla, H.P.
45.	5214	09/2014	Desk and wave flume studies for the design of breakwater for the development of fishery harbour at Harne in Maharashtra
46.	5215	09/2014	Identification of repair materials and repair methodology for arresting seepage of Dimbhe dam, Maharashtra

47.	5216	09/2014	Mathematical model studies for wave tranquility for the proposed development of port facilities at Sagar Island, WB
48.	5217	09/2014	Mathematical model studies for ship maneuvering for the proposed development of port facilities at Sagar Island, WB
49.	5218	09/2014	Mathematical model studies for ship mooring analysis for proposed development of port facilities at Sagar Island, WB
50.	5219	09/2014	Assessment of quality of masonry of Bhandardara Dam, Ahmednagar, MH
51.	5220	10/2014	Estimation of site-specific seismic design parameters for Tunga pumped storage project, West Bengal
52.	5221	10/2014	Hydraulic model studies for the proposed bridge across river Tapi on Vadodara-Mumbai Expressway of NHAI, Gujarat
53.	5222	10/2014	Estimation of reservoir capacity and sedimentation of TAWA reservoir using integrated bathymetry survey system and HP-II project
54.	5223	10/2014	Hindcasting studies for assessing the performance of spillway and energy dissipation Indira Sagar Dam, M.P.
55.	5224	10/2014	Hydraulic model studies for modified design of Mangdechhu Dam spillway, Bhutan
56.	5225	10/2014	Hydraulic model studies for Subansiri Dam spillway with extended chate ending in ski-jump bucket
57.	5226	11/2014	Desk and wave flume studies for the design of breakwaters for the development of fishery harbour at Manjeshwaram in Karaigod, Kerala
58.	5227	11/2014	Non-destructive testing of repaired beam of TA foundation of Unit No-6 Rourkela Steel Plant SAIL (Odisha)
59.	5228	11/2014	Hydraulic model studies for Indira Sagar Dam spillway MP 1:60 scale 2D sectional model
60.	5229	11/2014	Mathematical model studies for the development of fish landing centre at Manjaguri in Uttar Kannada, Dist. Karnataka
61.	5230	11/2014	Determination of geotextile properties of Geobags from Water Resources Dept., Siwan, Bihar
62.	5231	11/2014	Rock mechanics studies for Kumbhe HE project, Maharashtra
63.	5232	12/2014	Hydraulic model studies for desilting chamber for Punatsangchhu-II HE Project, Bhutan
64.	5233	12/2014	Hydraulic model studies for discharging capacity for full and partial gate operation of Punatsangchhu-I Dam spillway, Bhutan
65.	5234	12/2014	Mathematical model studies for hydro-dynamics for project Varsha
66.	5235	12/2014	Hydraulic model studies for power intake of Punatsangchhu HE Project, Bhutan
67.	5236	12/2014	Desk and wave flume studies for the design of breakwaters for the development of fishery harbour at Arthankal In Alapuzha, Kerala
68.	5237	12/2014	Hydraulic model studies for Punatsangchhu-II Dam spillway, Bhutan
69.	5238	12/2014	Mathematical model studies for littoral drift, shoreline evolution and mitigation measures for outer Cochin Port Trust
70.	5239	12/2014	Wave tranquility studies for 2nd stage development of Karwar Port, Karnataka
71.	5240	01/2015	Assessment of turbine efficiency under different reservoir levels at Kopili H.E. project, Assam
72.	5241	01/2015	Hydraulic model studies for Teesta-IV Dam Spillway, Sikkim, 1:60 Scale 3D Comprehensive Model

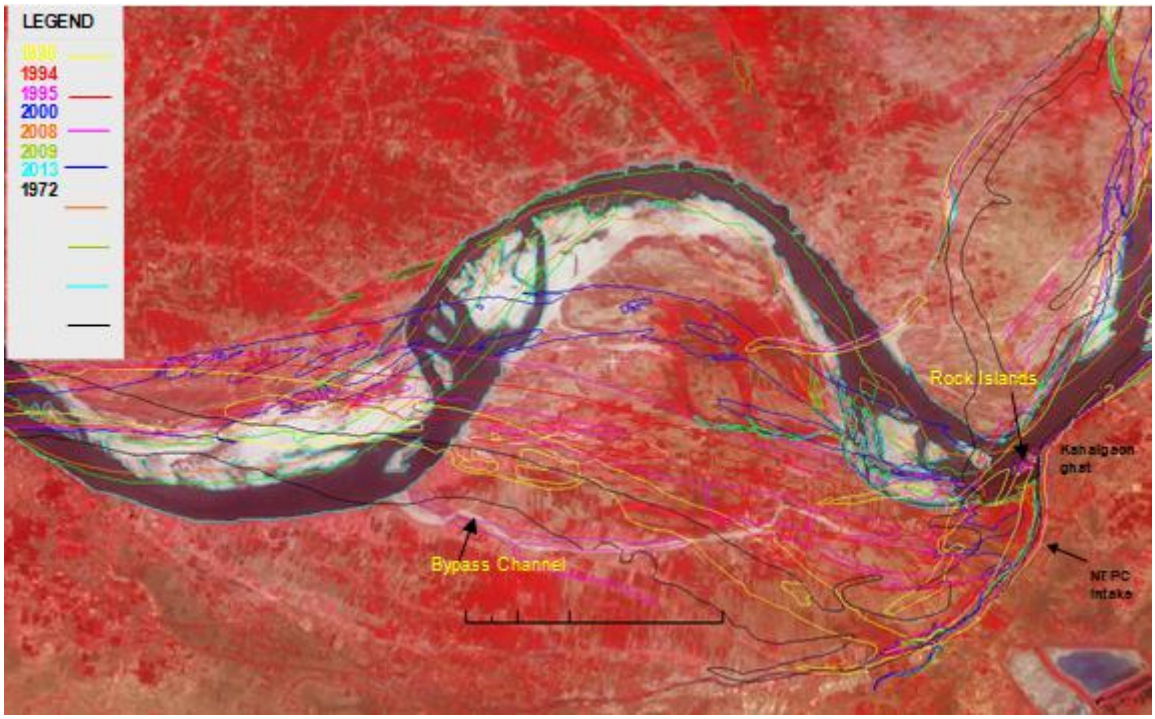
73.	5242	01/2015	Mathematical model studies for shoreline changes at ONGC plant and pipelines near Odalarevu village, East Godavari, A.P.
74.	5243	01/2015	Desk and wave flume studies for the design of coastal protection works at ONGC plant and pipeline near Odalarevu, East Godavari, A.P.
75.	5244	01/2015	Analysis and interpretation of Dam Instrumentation Data for the period January 2013 to December 2013 for non-overflow Block 13, Indirasagar Dam, M.P.
76.	5245	02/2015	Identification of repair materials and repair methodology for strengthening of Krishnarajasagar Dam, Karnataka
77.	5246	02/2015	Area drainage studies for proposed integrated thermal power project near village Darlipali, Odisha
78.	5247	02/2015	Mathematical model studies for littoral drift and shoreline changes at Vatanapally Panchayat, Kerala
79.	5248	02/2015	Mathematical model studies for the development of fishing harbour at Bhatkal in Uttara Kannada, Karnataka
80.	5249	02/2015	Field investigation to suggest proper flow measuring installations at the site of M/s Hindalco Industries Ltd., Ranchi
81.	5250	02/2015	Mathematical model studies for the proposed development of port facilities at Hazira, Gujarat
82.	5251	02/2015	Wave flume studies for the design of training walls/groynes for the development of fishery harbour at Manjagund, Karnataka
83.	5252	02/2015	Mathematical model studies for assessment of wave tranquility and shoreline changes for the proposed development of Mini Fishing Harbour at Thottapally, Kerala
84.	5253	02/2015	Mathematical model studies to suggest remedial measures to minimize likely siltation near quaside for M/s Cochin Shipyard Ltd
85.	5254	02/2015	Estimation of site specific seismic design parameters for Goriganga III-A Hydroelectric Project, Uttarakhand
86.	5255	02/2015	Desk studies for the design of coastal protection works at Porbander, Gujarat
87.	5256	02/2015	(SECRET)
88.	5257	02/2015	Design of anti-surge device for the rising mains of Borghat-I lift irrigation scheme, Taluka Mulshi, Dist. Chandapur
89.	5258	02/2015	Tracer studies for detecting leakage through hillock at Upper Manar Medium Project, Nanded, Maharashtra
90.	5259	02/2015	Studies for hydrodynamics and siltation for deepening of approach channel at Mormugao Port, Mormugao
91.	5260	02/2015	Mathematical model studies for assessment of shoreline changes for Sbth Pipeline at Umbrhat Beach, Hazira, Gujarat
92.	5261	02/2015	Desk and wave flume studies for the design of coastal protection measures for the exposed ONGC pipeline at Umbhrad, Hazira, Gujarat
93.	5262	03/2015	Identification of suitable repair materials and repair methodology for treatment of upstream face of Shivsagar Dam, Maharashtra
94.	5263	03/2015	Mathematical model studies for flood protection measures of Jabber Khad, H.P.
95.	5264	03/2015	Calibration of Integrated Gate, Doppler and Transit-Time Ultrasonic Flowmeters provided by KBJNL, Karnataka
96.	5265	03/2015	Mathematical model studies for wave tranquility for the proposed development of port facilities at Nandgaon, Maharashtra

97.	5266	03/2015	Hydraulic model studies for protection and restoration of Eastern Kosi embankment and spurs, Bihar
98.	5267	03/2015	Hydraulic model studies for reservoir flushing for Mangadechhu Hydroelectric project, Bhutan
99.	5268	03/2015	Additional hydraulic model studies for assessment of scour downstream of Salma Dam spillway, Afghanistan
100.	5269	03/2015	Hydraulic model study for the proposed bridge across Narmada River on Vadodara-Mumbai Expressway of NHAI-Gujarat
101.	5270	03/2015	Mathematical model studies for shifting of Navigational Channel of Kandla Port, Gulf of Kutch
102.	5271	03/2015	Mathematical model studies for alternate dumping site for disposal of dredged material from proposed multi-purpose terminal at Karanja, Uran, Maharashtra
103.	5272	03/2015	Mathematical model studies for hydrodynamics and siltations for proposed new berth container terminal for M/s JNPT, Navi Mumbai
104.	5273	03/2015	Drag evaluation for combat wheeled vehicle model for VRDE, Ahmednagar, Maharashtra
105.	5274	03/2015	Estimation of site-specific seismic design parameters for Punatsangchhu-II Hydroelectric projects, Bhutan for M/s WAPCOS Ltd
106.	5275	03/2015	Revision of site-specific seismic design parameters for Punatsangchhu-I HEP, Bhutan
107.	5276	03/2015	Mathematical model studies for surge analysis of Dongargaon-Thanegaon lift irrigation scheme
108.	5277	03/2015	Storm wave hindcasting studies for the proposed development of outer harbour at V.O. Chidambaranar Port, Tuticorin
109.	5278	03/2015	Physical hydraulic model studies for the modified layout of Fourth Container Terminal at JNPT, Mumbai
110.	5279	03/2015	Analysis and interpretation of seismological data for Indirasagar project, M.P.
111.	5280	03/2015	Micro-earthquake studies for Sapta Kosi Sun Kosi dam multipurpose project and Sun Kosi storage cum diversion scheme, Nepal
112.	5281	03/2015	Field studies for rating of Tungabhadra right bank power canal at km 0.750, Low Level Canal at km 2.842, LLC at km 118.700 and LLC at km 251.850, Tungabhadra dam, Karnataka
113.	5282	03/2015	Mathematical model studies for assessing the effect of additional structures on Limbdi branch Canal for Sardar Sarovar Narmada Nigam Ltd., Gujarat

RIVER ENGINEERING

5177-MORPHOLOGICAL STUDIES TO ASSESS THE CHANGES IN PLAN FORM OF RIVER GANGA NEAR INTAKE OF KAHALGAON SUPER THERMAL POWER STATION OF NTPC, BIHAR

The raw water intake of Kahalgaon Super Thermal Power Project of NTPC is located on the right bank of river Ganga at about 1.0 km upstream of Kahalgaon Ghat in District Bhagalpur, Bihar. The total raw water requirement including makeup water requirement for cooling tower was about 15000 m^3/hr (4.16 m^3/s). At the time of construction of Intake well in 1990-91, the deep channel of river Ganga was along right bank near the Intake well. With the passage of time, deep channel has gradually shifted away from intake location due to meandering tendency of river Ganga. It was informed by the project authorities that they have been facing problem during lean-season (i.e. February-March) to get adequate depth of water to run the pumps at full capacity. Due to shifting of active deep channel to the left side, far away from right bank, water approaches the intake from the pool near rock islands, in reverse direction for last many years. Analysis of satellite imageries and topo-sheets for more than past 40 years indicated the tendency of deep channel of river Ganga to revert back towards its previous course near right bank but at a slow pace. Therefore, on the basis of the analysis of topo-sheets and satellite imageries of different years, the observations/discussions with project engineers and local people made during the site inspections it was recommended to maintain the existing channel leading water in reverse direction from kahalgaon ghat / (rock island) to the NTPC intake by dredging so that the channel should be deep enough to carry sufficient water. It was also recommended to monitor the development of recognized major bye pass channel and discourage further man made obstructions/ closures along the existing right bank channel.

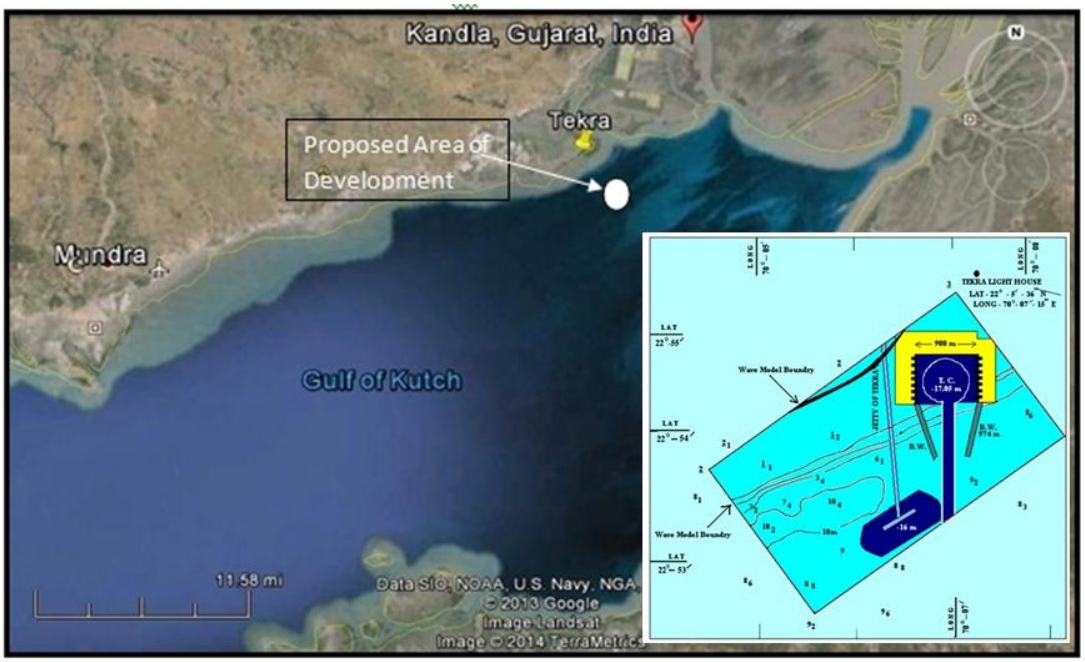


Comparison of deep channel configuration over the past 40 years

5180 -WAVE TRANQUILITY STUDIES FOR THE PROPOSED MEGA CONTAINER TERMINAL OFF TEKRA NEAR TUNA, KANDLA PORT

The Kandla Port proposes to develop a Mega Container Terminal (MCT) at about 14 km west of the Kandla creek outfall adjacent to the T-shaped Jetty off Tekra near Tuna. The site is located between 22° 54′ 25.27″ N - 22° 55′ 3.15″ N Latitude and 70° 06′ 21.56″ E – 70° 07′ 23.48″ E Longitude. The original layout consisted of two breakwaters of 974m length each and a basin of size of about 900m x 790m would be dredged to (-) 17.05 m below Chart Datum (CD) close to the inter-tidal zone with total quay length of 2100 m for providing berthing for 6 vessels. The wave tranquility conditions in the proposed layout would be important for the operation of the MCT. The predominant waves in the development area of Mega MCT are from 235° bearing north (approx. SSW direction) during the South West Monsoon season along the natural orientation of the creek with 2.0 m significant height exceeding one day in a year. The permissible limit of the wave tranquility for operation of container ships has been considered as 0.5 m.

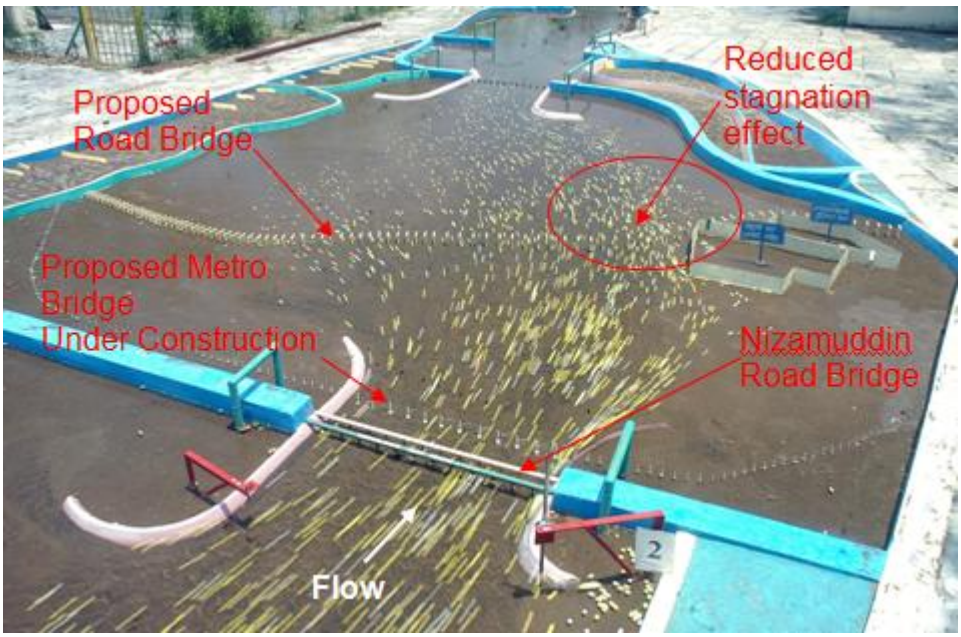
The physical wave model studies were conducted at CWPRS with geometric similar (G.S.) scale of 1:150 by reproducing random incident waves of Hs = 2.0m and Tp = 5.5 sec from 235° bearing north and using multichannel data acquisition system. Two options were examined for optimizing the layout for wave tranquility. In the layout MCT Option - 1, the suggested breakwater configuration consists of reduced length of 680 m of West Breakwater and 825 m length of East Breakwater aligned more along the flow conditions. In the layout MCT Option - 2, an attempt has been made to create an additional berthing space on the outer face of the basin on the lee side of west breakwater. The breakwater lengths have been reduced by about 450 m mainly in the deep water portion and the savings in the cost is expected to be as much as about 40%. The wave tranquility studies conducted with the option of full removal of the East Breakwater for layout MCT Options - 1 and 2 indicated that this has no significant effect on the wave tranquility conditions in the dredged basin area. The East Breakwater is important only for diverting the ebb flow away from the basin and the requirement of the same needs to be checked in the hydrodynamic and siltation studies.



Mega Container Terminal at Kandla Port, Gujarat

5195-HYDRAULIC MODEL STUDIES FOR EXTENSION OF BARAPULLAH ELEVATED ROAD ACROSS RIVER YAMUNA (PHASE III) FROM SARAIKALE KHAN TO MAYUR VIHAR AT NEW DELHI

Project Manager, Flyover Project Division, PWD, Govt of Delhi had proposed to construct a road bridge across river Yamuna at Delhi, downstream of Nizamuddin road bridge. CWPRS was approached with a request to examine the technical feasibility of the proposal through hydraulic model studies. The studies were carried out on the existing mobile bed model of river Yamuna at Delhi, constructed to a horizontal scale of 1:300 and a vertical scale of 1:60 covering a river reach of 50 Km from Palla to Jaitpur. The model bed from Wazirabad barrage to 5 km downstream of Okhla barrage was updated and moulded as per post flood survey of 2007. The model studies were carried out for the proposed bridge alignment. Alignment of proposed bridge axis approximately 1.2 km downstream of the Nizamuddin road bridge was found hydraulically satisfactory. The bridge alignment proposed by the project authority resulted in an afflux of 15, 12, 10 cm for discharges of 7022, 9910 and 12750 m^3/s respectively. Also, some stagnation effect near Maharani baug power grid complex was observed. A small change in the orientation of pier and increase in span to 42.50m was suggested to avoid the stagnation in flow adjacent to Maharani baug power grid complex. The water levels on upstream of the bridge and afflux remained same even after modifications to the pier orientation of the bridge. The modified bridge proposal will not cause any major change in river regime. The afflux experienced at the proposed bridge axis being small, asymptotically reduced to un-measurable value in a distance of 1.2 km. The afflux upstream of the Nizamuddin road bridge was negligible and diminished to nil. There was no effect of afflux due to proposed bridge construction beyond the Nizamuddin road bridge.



Flow pattern in the vicinity of proposed road bridge approximately 1.2 Km downstream of the Nizamuddin road bridge

5197-DESK STUDIES FOR PROPOSED KHARKAI BARRAGE SITE NEAR GANJIA VILLAGE, JHARKHAND

Kharkai Barrage is proposed on river Kharkai at Ganjia, under Subarnarekha Multipurpose Project, Jharkhand. The location of the proposed barrage is about 1 km downstream of the confluence of river Kharkai with the river Sanjay. The hydraulic model studies of the barrage were conducted by CWPRS way back in 1980 to 1983. The technical reports bearing No. 2002 of August 1981 and 2149 of October 1983 were sent, which contained the results and recommendations based on the model studies. However, due to various reasons, the barrage was not constructed at that time.

Recently, the proposal was revived and various hydraulic design parameters were updated using the latest data. The hydraulic design parameters were also adapted to fit the latest data and demand of upstream and downstream stakeholders. Few changes were made to the structure of the barrage and the project authorities were apprehensive of those changes and desired CWPRS to verify the same based on their experience in conducting the model studies. It is found that the design discharge, HFL, Pond level and crest level of the barrage are the main parameters that have been changed. In view of these changes, the energy dissipator length and end sill top level have been marginally changed, which seems to be satisfactory. It was also found from the site inspection that there was no major change in the plan forms of the river when compared with the old data of 1981-83 and major sedimentation is not seen near the site. In view of this, it was generally concluded that the results of the model studies conducted earlier are still valid given the assumption that the tail water rating curve remains still the same. Hence, the design based on earlier recommendations is satisfactory. It is recommended to provide bank protection in the form of concrete blocks of size 0.5mX0.5mX0.6m over a geofabric filter for the left afflux bund between cross-sections 3 to 7. In addition, it is recommended to provide launching apron to stabilize the slope protection. It is also suggested to clear the debris of a collapsed road bridge still lying on the immediate downstream of the proposed barrage site as it may cause adverse flow conditions downstream of the barrage.

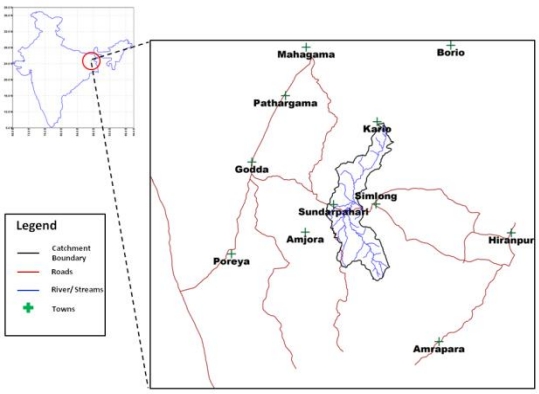
Excavation for left abutment of Kharkai barrage

5201-WATER AVAILABILITY STUDIES AT PROPOSED BARRAGE LOCATION IN GUMANI RIVER FOR M/S JINDAL POWER LIMITED THROUH M/S WAPCOS(I) LIMITED

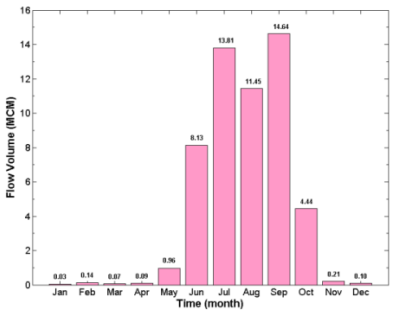
M/s Jindal Power Limited is establishing a 1320 MW thermal power plant near Sundarpahari village in Godda district of Jharkhand. Presently, Government of Jharkhand has allowed JPL to draw 14.03 MCM of water from the proposed weir site across river Gumani in addition to the other two sources, namely Sunder dam built across river Sunder, and another weir across Jalhara river respectively. However, JPL wishes to explore the possibility of drawing an additional 18.0 MCM of water totaling up to 32.0 MCM from the proposed weir location across river Gumani.

A reconnaissance survey was carried out to have firsthand information on the hydrology of the river basin under consideration. Spatial information available on detailed survey map pertaining to study area was digitized and a Digital Elevation Map (DEM) is developed under a suitable GIS environment. Remotely sensed data of the study area as obtained from Global Land Cover Facility (GLCF), NASA Landsat Program (www.landcover.org) is used to interpret the land-use/ land-cover information of the study area. The daily rainfall data recorded at Sundarpahari for a period of 25 years from 1975-1999 is used in this study for estimation of runoff.

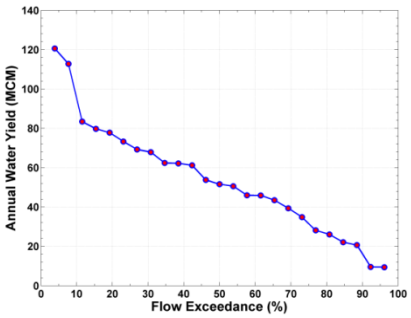
A hydrological model based on SCS-CN method is employed to estimate the surface water runoff of the Gumani river basin. Based on land-use/ land-cover, soil-type and antecedent moisture condition prevailing in the study area, appropriate curve numbers were used to estimate the surface runoff of the river basin. A flow duration curve was prepared based on the annual volume of surface runoff at the proposed weir site. Water availability was estimated at the proposed weir site across river Gumani. The 90% dependable water yield for Gumani river basin at the proposed weir site was 16.21 MCM. The 75% and 50% dependable yields were 31.49 MCM and 51.59 MCM respectively. The mean monthly flow obtained in this study provides an opportunity for effective withdrawal of water from the Gumani river basin.



Index Map of Study Area



Mean monthly flow volume at the weir site

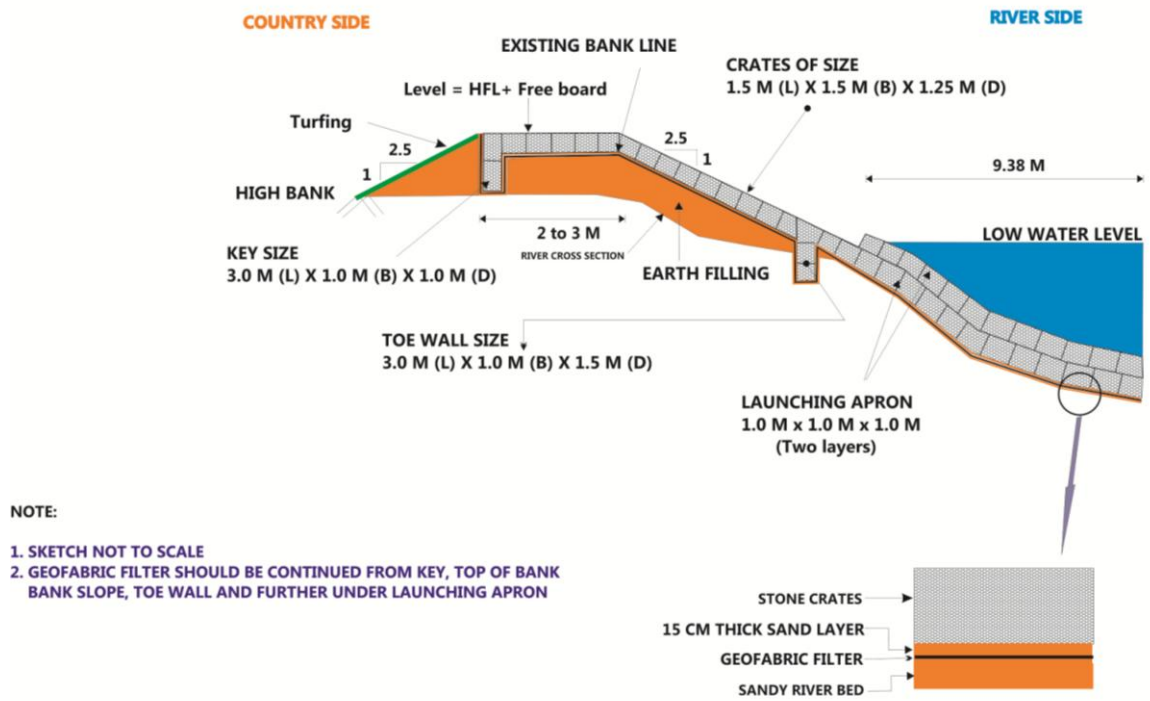


Flow Duration Curve

5203-MATHEMATICAL MODEL STUDIES FOR FLOOD PROTECTION WORKS IN SUKETI KHAD AND ITS TRIBUTARIES, HIMACHAL PRADESH

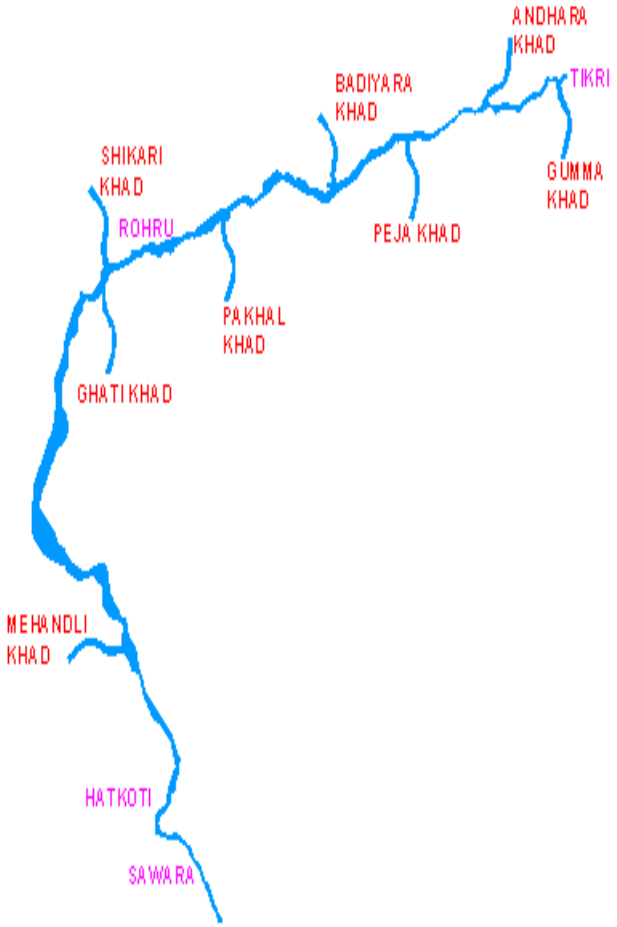
Suketi Khad is a tributary of river Beas in Kangra district of Himachal Pradesh which rises from the south facing slopes of Dhauladhar range. A number of small channels join the Suketi river in its upper reaches. The river has formed huge terraces, most of which are under cultivation. During floods, valuable agricultural land was either washed away due to erosion or became unproductive due to deposition of silt carried by the flood water. The release of huge quantity of silt water in to the Suketi Khad from the silt ejector of Baggi balancing Reservoir near Sundernagar and mining activity were the concern for the project authorities. The valuable properties, agricultural lands, government properties, etc., located adjacent to the banks of the Suketi Khad also get extensively damaged due to floods. Concerned over these problems, the Executive Engineer, Irrigation and Public Health (I&PH) Division, Baggi Himachal Pradesh requested Central Water and Power Research Station (CWPRS), Pune to conduct model studies for suggesting suitable flood protection measures for the reach under consideration.

1-D mathematical model (HECRAS) was used to arrive at optimal values of hydraulic parameters for deciding suitable bank protection works. Based on the velocities, bank protection works in the form of Gabion crates in sloping bank, embankments and concrete wall were suggested for flood protection along the banks of Suketi Khad and its tributaries. The Gabion walls ranging from height 2.5 m to 4.4 m was also suggested at places where the bank slopes were steep and space restrictions encountered particularly near confluence of Suketi Khad with River Beas. Toe wall in gabion crates and launching apron of suitable sizes for different river reaches along with geo-fabric filter was recommended.



5213-MATHEMATICAL MODEL STUDIES FOR FLOOD MANAGEMENT OF PABBAR RIVER IN TEHSIL ROHRU, DISTT. SHIMLA, HIMACHAL PRADESH

The Pabbar River originates in Gangdaridhar range of great Himalayas at about 5100 m above mean sea level. The river flows 55 km in south-west direction from its source to reach Rohru town and turns to south-east direction after Rohru. Due to deforestation of catchment area and other reasons, the intensity of flashy floods has aggravated resulting in immense damage to the life, crops and property. An integrated development plan for Pabbar valley has been prepared by the irrigation and public health department, Government of Himachal Pradesh and construction of embankments form a part of it for reclamation and protection of adjacent fertile lands and other properties. Irrigation and power research institute (IPRI), Amritsar, Punjab had conducted hydraulic model studies in 1978 and suggested construction of system of embankment and revetments/spurs for protecting the river banks. Central Water Commission (CWC) had suggested getting the mathematical model studies conducted by CWPRS before taking up construction of the embankments. Mathematical model study conducted at CWPRS for passage of 100 year return period discharge indicated that there was no necessity of construction of embankments at all places as proposed by the project authorities. The modification to the embankments were accordingly suggested and computed water levels of River Pabbar were given for finalizing the top level of the embankment by adding sufficient free board. It was suggested to provide the protection for sloping bank for few reaches and protection works in the form of earthen embankments for most of the reaches. Slope pitching and launching apron consisting of two layers of stones in crates laid over geofabric filter was evolved from the studies based on the hydraulic design parameters.



Plan of river Pabbar from Tikri to Hatkoti with its tributaries

5221-HYDRAULIC MODEL STUDIES FOR THE PROPOSED BRIDGE ACROSS RIVER TAPI ON VADODARA-MUMBAI EXPRESSWAY OF NHAI, GUJARAT

National Highway Authority of India (NHAI) has proposed a road bridge across river Tapi on proposed Vadodara-Mumbai Expressway. The location of the proposed bridge is about 14 km upstream of the existing road bridge. Project authority requested CWPRS to carry out hydraulic model studies for verifying different aspects such as flow conditions at the proposed bridge site, adequacy of the bridge alignment and waterway, afflux due to bridge and scouring at the piers etc.

Hydraulic model studies were conducted on 1-D mathematical model and a physical model with horizontal scale of 1:250 and vertical scale of 1:70. It was observed that the proposed waterway of 793.20 m was adequate to pass the design discharge of 34,000 m^3/s with the afflux of 0.15 m. HFL for the design discharge was found to be at RL 23.45 m. Maximum scour level of -27.87 m and -5.50 m were expected as per Inglis and Shen's approach respectively. It was suggested to provide foundation after considering sufficient grip length. Higher velocities in the range of 3.0 m/s to 4.2 m/s were observed at the banks adjacent to right abutment and at many other places in the upstream, therefore to avoid possibility of bank erosion, protection work in the form of stones in crates over suitable synthetic filter were recommended. In addition, it was recommended to provide launching apron where ever toe of slope protection was not supported by rock outcrop to stabilize the slope protection.

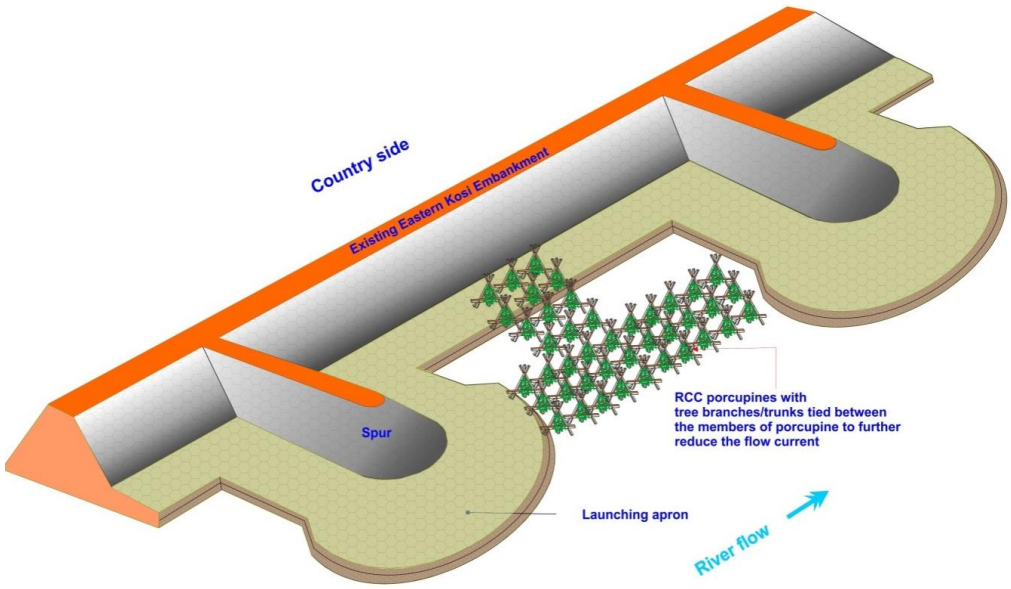
Flow lines for a discharge of 19,057 m^3/s

5266-HYDRAULIC MODEL STUDIES FOR PROTECTION, RESTORATION OF EASTERN KOSI EMBANKMENT AND SPURS, BIHAR

River Kosi brings in large quantity of sediment which gets deposited at different reaches of the river as it enters the plains of Bihar (India), due to reduction in longitudinal slope. This leads to braiding of river and the river changes its course repeatedly. The embankments on both banks and series of spurs were constructed to combat the fury of this river. Due to the variation in direction of flow owing to change in discharge and sedimentation, the conditions near the spurs change from repelling to sometimes attracting, whereby the flow tends to attack the embankments. In order to strengthen the existing embankment and spurs, the Water Resources Department, Government of Bihar desired CWPRS to carry out studies to assess the restoration and protection works for the embankment and spurs designed by project authorities based on the parameters extracted from the hydraulic model studies on the existing Kosi river model at CWPRS, Pune for preparing the concrete proposal to execute the same with the financial help of World Bank.

The mobile bed model of river Kosi extending from Chatra up to 80 km downstream of Kosi barrage, built to a distorted scale of 1:70 (V) and 1:500 (H) existing at CWPRS was used to extract different hydraulic parameters, flow conditions, etc., for the design of suitable protection works for the reach under consideration.

A proper bank protection work in the form of flexible slope protection and launching apron over non-oven geo-fabric filter was recommended. This work is mainly suggested for the existing embankments and spurs. To avoid the direct impinging flow on to the embankment protection works, it is recommended to provide permeable porcupines so that they absorb the momentum of the flow and avoid the eddy formation downstream of the spurs.



5269-HYDRAULIC MODEL STUDIES FOR THE PROPOSED BRIDGE ACROSS RIVER NARMADA ON VADODARA-MUMBAI EXPRESSWAY OF NHAI, GUJARAT

National Highway Authority of India (NHAI) has proposed a road bridge across river Narmada as a part of the Vadodara-Mumbai Expressway. The location of the proposed bridge is about 8 km down stream of the existing road bridge on river Narmada at Bharuch. Project authority requested CWPRS to carry out hydraulic model studies for verifying different aspects such as flow conditions at the proposed bridge site, adequacy of the bridge alignment and waterway, afflux due to bridge and scouring at the piers etc.

Hydraulic model studies were conducted on a physical model with a horizontal scale of 1:500 and vertical scale of 1:100 in addition to one-dimensional mathematical model study. It was observed that the proposed clear waterway of 1730 m was adequate to pass the design discharge of 74,500 m^3/s with the afflux of 0.4 to 0.5 m. HFL for the design discharge was found to be at RL 12.25 m. Maximum scour level of -35.63 m and -34.23 m are expected as per Inglis and Shen's approach respectively. It is suggested to provide foundation after considering sufficient grip length. Higher velocities in the range of 3.0 m/s to 5.6 m/s were observed along the guide bund on left side, therefore to avoid possibility of erosion on sloping side and bed, protection work in the form of stones in crates laid over suitable synthetic filter are recommended on the sloping side of guide bund alongwith launching apron.

Flow conditions near proposed bridge and guide bund

RIVER AND RESERVOIR SYSTEMS MODELLING

5174-AREA DRAINAGE STUDIES FOR PROPOSED POWER PLANT OF RIL AT HAZIRA

The Reliance Industries Limited (RIL) is proposing to generate 380 MW power by building and operating thermal power project at their Triangular plot at Hazira, Gujarat. In this regard, RIL have requested WAPCOS to conduct various studies for the said project. WAPCOS in turn entrusted the studies on determination of Safe Grade Elevation (SGE) and Area Drainage Studies (ADS) for the said plot to CWPRS. Accordingly, CWPRS undertook the said studies. The SGE study was carried out and a technical report (No. 5131 of January, 2014) was submitted to project authorities. The Triangular plot is on the right bank of river Tapi with NTPC Limited on its northeast, KRIshi BHarati COmpany (KRIBHCO) on east and to its northwest is RIL refinery complex. There are two garland streams N1 and N2 that drain the flood water from surrounding area to Tapi river. Stream N1 drains flood water from Limla area, KRIBHCO, ABG Cement and NTPC areas. While N2 stream originates north of Triangular plot near NTPC, flows west and drain into Tapi estuary as shown in figure.

Site inspection to the Triangular plot area was carried out by CWPRS to comprehend the existing drainage system and to collect the field data. The available rainfall data (daily and hourly) were made available by WAPCOS from India Meteorological Department (IMD). The Extreme Value Analysis (EVA) of the daily and hourly rainfall data was carried out using EV-I distribution and 1-day and sub-daily maximum rainfall for different return periods were estimated.

The total project area of RIL was split into sub-plots based on the function and peak flood of sub-plots was estimated. Similarly, for garland stream N1 and N2 peak flood discharge at different locations was estimated for the extreme rainfall using appropriate rainfall-runoff method. Based on the layout plan and the SGE for plant the dimensions of main storm drains were computed for efficient evacuation of storm water from plant area. Further, geometric dimensions of streams N1 and N2 also were estimated, based on the flood discharges computed based on the GIDC layout plan and extreme rainfall (100-yr return period). Using the layout plan of power plant by RIL, locations/points for storm water outfall and also plan for SWD inside and outside the Triangular plot were suggested.

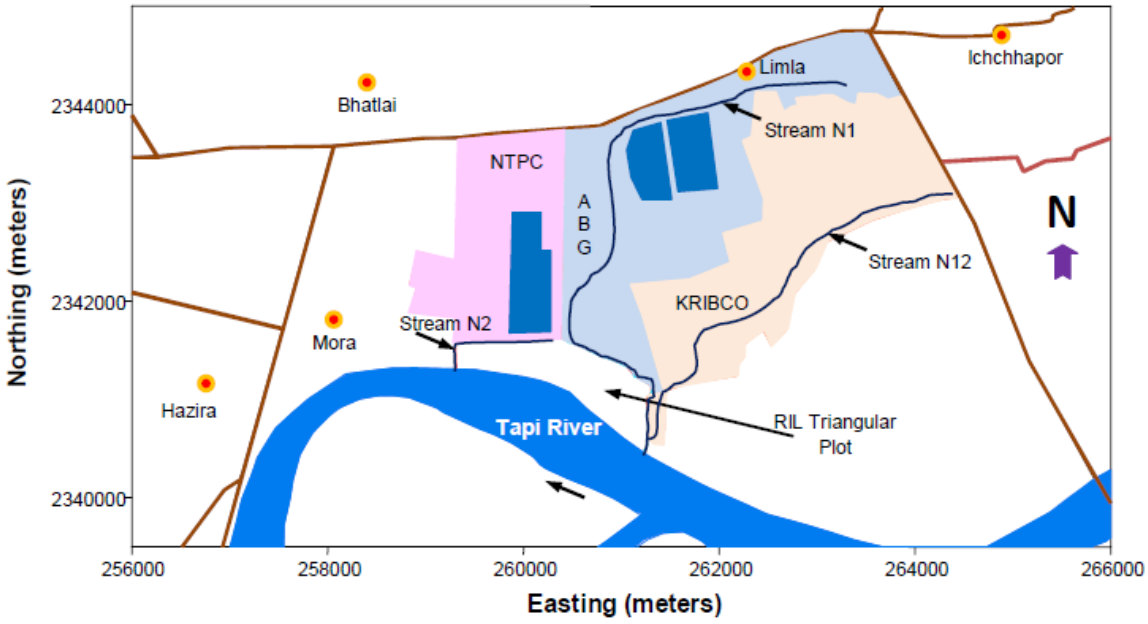


Figure: Map Showing Outside Streams N1 and N2 with Catchments and Triangular Plot

5182- EXTREME VALUE ANALYSIS OF METEOROLOGICAL DATA FORBANSWARA NUCLEAR POWER PROJECT, RAJASTHAN

Nuclear Power Corporation of India Limited (NPCIL) proposes to setup a Nuclear Power Plant (NPP) with an installed capacity 4x700 MW at Banswara, Rajasthan. As NPP needs to be safeguarded against natural hazards, Extreme Value Analysis (EVA) of meteorological data forms a part of the technical and engineering investigations for designing NPP. For the proposed NPP at Banswara, CWPRS carried out EVA of rainfall and temperature data recorded at Banswara meteorological station, which is in the vicinity of the NPP.

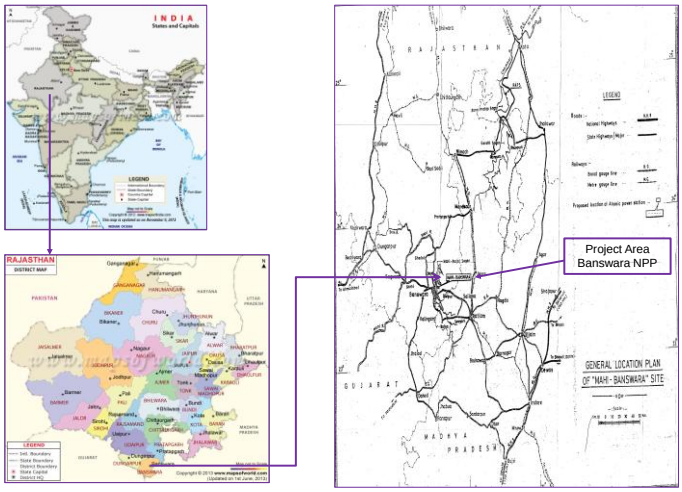
Daily rainfall data recorded at Banswara for the period 1969-2012 was used for EVA. Similarly, the surface temperature and air temperature (dry bulb, wet bulb and dew point) data recorded at Banswara for the period 1969-2009 was used for EVA of temperature.

Order Statistics Approach (as per Atomic Energy Regulatory Board guidelines) was applied for determination of parameters of the Gumbel and Frechet distributions. Wald-Wolfowitz and Mann-Whitney-Wilcoxon tests were adopted for checking the randomness and homogeneity of the data series derived; and the results showed that the series were random and homogeneous.

Based on EVA of daily rainfall, the 10000-year (yr) return period Mean + 1σ (where Mean denotes the estimated rainfall and σ the standard error) values of 1-day maximum rainfall was obtained from Gumbel and Frechet distributions are 945.7 mm and 19958.9 mm. EVA of temperature data showed that the difference between the estimated temperature using Gumbel and Frechet distributions varied between 1 °C and 3 °C for return period 50-yr and above.

GoF tests such as Anderson-Darling and Kolmogorov-Smirnov tests were applied to check the adequacy of fitting of Gumbel and Frechet distributions. A diagnostic test of D-index was used for selection of a suitable distribution for EVA. From the results, it was observed that the Gumbel distribution is better suited for EVA of rainfall and surface temperature whereas Frechet distribution for EVA of air temperature.

The study recommends the 10000-year return period Mean + 1σ value of 945.7 mm for 1-day maximum rainfall, 1000-yr return period Mean + 1σ value of 59.2 °C for maximum temperature and Mean-1σ value - 12.5 °C for minimum temperature (using Gumbel); and 1000-yr return period Mean + 1σ values of dry bulb, wet bulb and dew point temperature of 57.1 °C, 39.7 °C and 39.0 °C respectively (using Frechet), to be used as design parameters for the proposed NPP at Banswara.



Location map of the study area

5193-AREA DRAINAGE STUDIES FOR DETERMINATION OF SAFE GRADE ELEVATION FOR THERMAL POWER PROJECT OF M/S. NECL, VARAKAVIPUDI, ANDHRA PRADESH

Area drainage studies have been carried out to determine Safe Grade Elevation (SGE) for thermal power plant of M/s. NELCAST Energy Corporation (NECL) near Varkavipudi, Andhra Pradesh. M/s. NELCAST propose to set up a new Thermal Power Plant (TPP) of 2 x 660 MW near village Varkavipudi in Nellore District of Andhra Pradesh. The proposed site is at a distance of 24 km from Nellore railway station and about 130 km from Chennai airport. The studies have been carried out for estimation of SGE and to derive Storm Water Drainage (SWD) network for the proposed TPP.

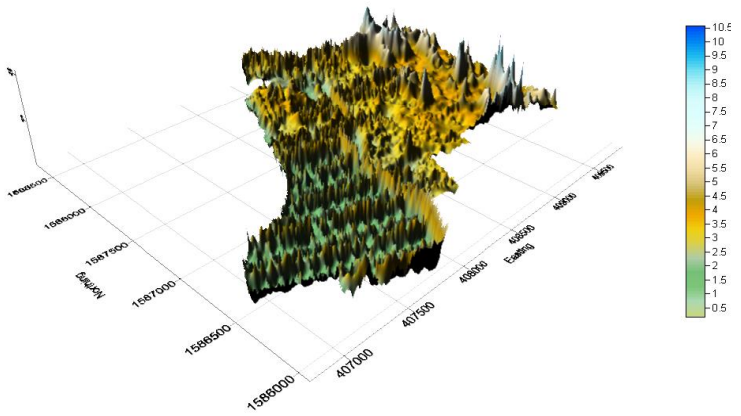
The project site is situated east of Buckingham canal, north of thermal power plant of M/s. TPCIL and west of Bay of Bengal. The general slope of terrain is in south west direction. The project area receives rainfall from south west and north east monsoon as well as due to cyclones. The terrain has a number of ponds that were also used for fish culture.

Inspection of site was carried out to get acquaintance with prevailing conditions and identifying likely locations where storm water from plant can be let out. The soil in the plant area is by and large sandy in nature. The vegetation cover over the area is very poor.

Daily rainfall data at six locations were collected and analyzed for estimation of rainfall depth with different return periods. Water levels at 5 different locations were observed from spring tide to neap tide. A review of water levels in a period of 24 hours shows 2 peaks and 2 troughs. Thus, it could be decided that rainfall with 6-hr duration could be used for design purpose.

It was also noticed during the site inspection that no stream, originating outside the plant boundary, flows through project area and continues towards Buckingham canal or sea. It was, therefore, decided after discussions with project authorities that Digital Elevation Model (DEM) of the project area can be developed. The rainfall for a duration of 6-hr was super-imposed on the DEM and preliminary SGE was derived considering topography of the region, tidal variations in Buckingham canal and in sea.

Discussions were held with project authorities to finalize SGE as 4.5m for important areas like main plant. It was also decided through series of discussions that sill level of the outfall channels multiple outlet channels are to be provided and draining into inland channel could be kept as 2.2m at the plant boundary and 2.7m for the outfall open sea. Storm water drainage network for the plant area has been derived with five outfalls in Buckingham canal and four outfalls in open sea. The storm water drainage network has been derived using trapezoidal section with smooth concrete lining



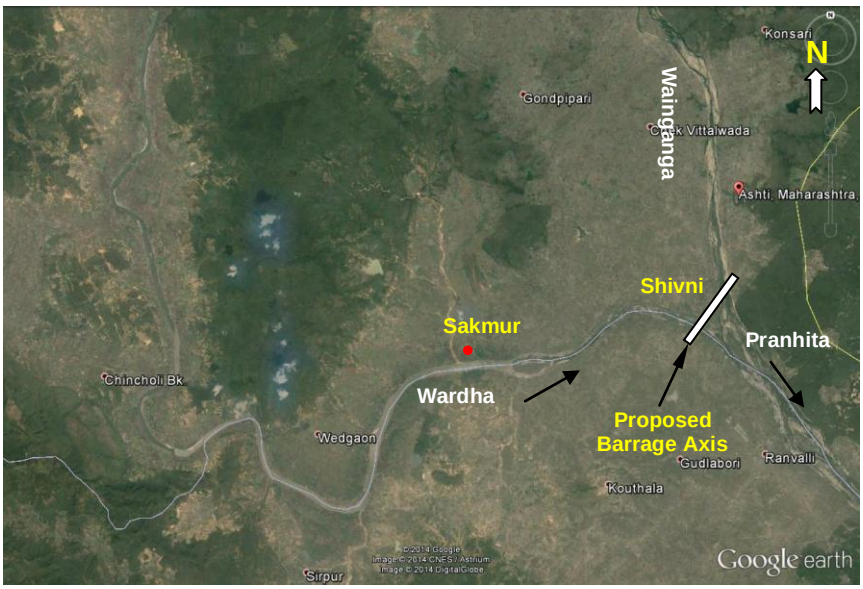
DEM of plant area of TPP of NECL near Nellore

5207- MATHEMATICAL MODEL STUDIES FOR BACKWATER EFFECT OF PROPOSED BARRAGE OF DR. B.R. AMBEDKAR PRANAHITA-CHEVELLA SUJALA SRAVANTHI PROJECT (PACKAGE 3), TELANGANA

The Irrigation & Command Area Development Department (I&CADD), Telangana have a proposal to harness water for irrigation and drinking water supply by commissioning Dr. B.R. Ambedkar Pranahita-Chevella Sujala Sravanthi Project (Package 3) through construction of a barrage on river Pranahita with an elevation of spillway at 152.0 m to harness a water of 144.74 MCM. The proposed barrage is situated at the confluence of rivers Wardha and Wainganga on the state borders of Maharashtra and Telangana. Maharashtra state has apprehension of backwater effect resulting in submergence of the fringe settlements near village Shivni upstream of the proposed barrage. In this regard, I&CADD requested Central Water and Power Research Station (CWPRS), Pune to conduct the mathematical model studies to assess the backwater effect of the proposed barrage. Accordingly, CWPRS carried out the studies on backwater effect adopting mathematical model technique.

Site inspection of the project and surrounding area was carried out by CWPRS officers to comprehend the existing stream network and to collect the field data. G-D data of rivers Wardha at Sakmur and Wainganga at Ashti, survey data such as longitudinal and cross sectional data of rivers Wardha and Wainganga and elevation-capacity of proposed barrage upto elevation RL 152.0 m were provided by project authorities. The available daily rainfall data from for the raingauges in the vicinity of project were procured by I&CADD from India Meteorological Department (IMD) and provided to CWPRS. The Extreme Value Analysis (EVA) of the daily river flow and daily rainfall data was carried out. The peak flood discharges of influencing catchments between G-D stations and barrage for different return periods were estimated using appropriate rainfall-runoff method and incorporated in flood routing model.

Based on the requirement of the project, 1-D hydraulic flood routing model HEC-RAS (steady state) was adopted to study the backwater effect of barrage for different flood events i.e. (i) observed flood (50.864.79 m3/s), (ii) conservative flood (73,297.8 m3/s) and (iii) combined flood (62,231.27 m3/s) discharges. Highest Water Levels (HWL) at the locations of interest in project area were extracted from model results. As required by the project authorities, an assessment of lowering of barrage height on the flood levels and resulting change in storage capacity of project was studied. The studies indicated that for reduction of 1.0 m in flood level at Shivni east, the barrage RL has to be lowered by about 1.23 m for observed flood, 1.30 m for 25-yr flood, 1.43 m for 50-yr flood and 1.59 m for 100-yr flood conditions, while the corresponding storage loss were to the extent of 36.96/1.31, 37.71/1.37, 41.95/1.48 and 44.95/1.62 MCM/Tcft respectively.



Vicinity map of Pranhita project area

5212- EXTREME VALUE ANALYSIS OF METEOROLOGICAL DATA FOR BHIMPUR NUCLEAR POWER PROJECT, MADHYA PRADESH

Nuclear Power Corporation of India Limited (NPCIL) proposes to setup a Nuclear Power Plant (NPP) with an installed capacity 4x700 MW at Bhimpur, Shivpuri district, Madhya Pradesh. As NPP needs to be safeguarded against natural hazards, Extreme Value Analysis (EVA) of meteorological data forms a part of the technical and engineering investigations for designing NPP. For the proposed NPP at Bhimpur, CWPRS carried out EVA of rainfall and temperature data in respect of Narwar and Shivpuri meteorological stations, which are in the vicinity of the NPP.

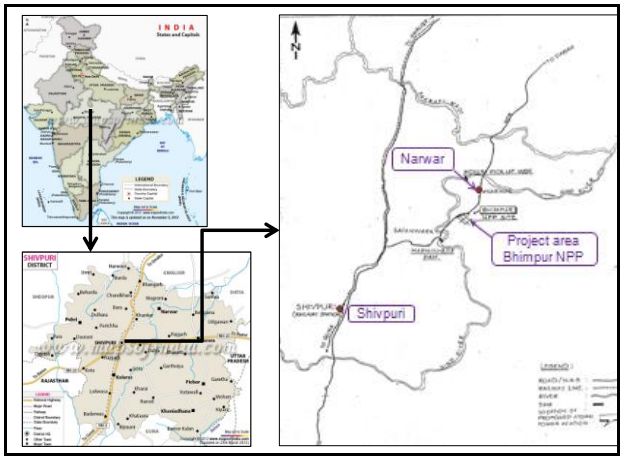
Daily rainfall data recorded at Narwar for the period 1988-2004 and hourly rainfall data related to the period 1971-1984 and 1990-91 for Shivpuri was used for EVA of rainfall. The n-hr maximum rainfall estimates for different duration (1-hr, 2-hr, 3-hr, 4-hr, 5-hr, 6-hr, 12-hr, 18-hr, 24-hr, 48-hr and 72-hr) estimated by Gumbel and Frechet probability distributions were used to develop intensity-duration-frequency curves. Similarly, the surface temperature and air temperature (dry bulb, wet bulb and dew point) data recorded at Shivpuri for the period 1969-2006 was used for EVA of temperature.

Order Statistics Approach (as per Atomic Energy Regulatory Board guidelines) was applied for determination of parameters of the Gumbel and Frechet distributions. Wald-Wolfowitz and Mann-Whitney-Wilcoxon tests were adopted for checking the randomness and homogeneity of the annual maximum and minimum data series derived; and the results showed that the series were random and homogeneous.

Based on EVA of daily rainfall, the 10000-year (yr) return period Mean + 1σ (where Mean denotes the estimated rainfall and σ the standard error) values of 1-day maximum rainfall was obtained from Gumbel and Frechet distributions are 705.7 mm and 11474.2 mm. EVA of temperature data showed that there is no appreciable difference between the estimated temperature using Gumbel and Frechet distributions.

GoF tests such as Anderson-Darling and Kolmogorov-Smirnov tests were applied to check the adequacy of fitting of Gumbel and Frechet distributions. A diagnostic test of D-index was used for selection of a suitable distribution for EVA. From the results, it was observed that the Gumbel distribution is better suited for EVA of rainfall and surface temperature whereas Frechet distribution for EVA of air temperature.

The study recommends the 10000-year return period Mean + 1σ value of 705.7 mm for 1-day maximum rainfall, 1000-yr return period Mean + 1σ value of 51.4 °C for maximum temperature and Mean-1σ value -6.3 °C for minimum temperature (using Gumbel); and 1000-yr return period Mean + 1σ values of dry bulb, wet bulb and dew point temperature of 52.8 °C, 36.6 °C and 35.7 °C respectively (using Frechet), to be used as design parameters for the proposed NPP at Bhimpur.



Location map of the study area

5246-AREA DRAINAGE STUDIES FOR PROPOSED INTEGRATED THERMALPOWER PROJECT NEAR DARLIPALI, DIST. SUNDARGARH, ODISHA

M/s. NTPC Ltd had proposed to set up a Thermal Power Plant with an installed capacity 3200 MW near Darlipali, Dist. Sundargarh, Odisha. The plant was proposed to be on left bank of Vasundhara nala about 30 km from Sundargarh, spread over an area of 712 hectares. The area drainage study for the Darlipali project site was entrusted to CWPRS.

The analysis of rainfall was carried out for five rain gauge stations using Gumbel Extreme Value (GEV), Log Normal (LN) and Log Pearson distributions for return period of 25, 50 and 100 year. The rainfall depth of 337 mm estimated using GEV distribution for return period of 25 years was used for further studies. The hourly rainfall depth of 128 mm was derived from the daily rainfall of 337 mm corresponding to 25 years return period. Time of concentration was estimated for Plant, Township, Ash dyke and Adjoining area using Kirpitch, California and Indian Road Congress (IRC) formulae. The component of flow from plant, township, ash dyke and adjoining area were estimated using rational method.

The flow from plant, township and ash dyke were added into discharge from adjoining area to obtain design discharge for storm water drainage (SWD) channels. Two alternatives have been considered for storm water drainage scheme. Based on the HFL derived using 1-D mathematical model, three outfalls are proposed on the reach of Vasundhara nala in Alternative I for discharge of storm water from plant, township, ash dyke and part adjoining area. In Alternative II the storm water from plant, township and part adjoining area is drained to the Vasundhara nala through single outfall and storm water from ash dyke and part adjoining area is drained to nala on the east of ash dyke through another outfall.

The cross sections of SWD channels were derived for design discharge using bed slope of 1:2500 and Manning's roughness coefficient of 0.02. The rectangular cross section were designed considering smooth lining similar to surface of smooth finished concrete for sides and bed.

Location map of thermal power plant near Darlipali

RESERVOIR AND APPURTENANT

5172-HYDRAULIC MODEL STUDIES FOR RESERVOIR SEDIMENTATION AND FLUSHING, DEVSARI HE PROJECT, UTTRAKHAND

The SJVNL has proposed to implement Devsari Hydro Electric Project (252 MW) on river Pinder in Alaknanda basin, Uttarakhand. The project is planned as a run of the river scheme with 35 m high dam at about 2.5 km downstream of confluence of Kailganga with Pinder river. Provision is made for annual flushing of reservoir through 5 nos. of low level sluice spillways. One dimensional mathematical model studies were carried out for estimating the likely sedimentation profile and assessing the performance of reservoir as desilting basin. The studies were also carried out on a physical scale model to confirm the results of mathematical model and assessing the extent of reservoir flushing. The physical model of Devsari Hydroelectric Project reservoir was constructed to a geometrically similar scale of 1:60 for the reach of Pinder river from 5.5 km upstream to 0.3 km downstream of dam axis and reach of Kailganga river from 3.5 km upstream to it's confluence with Pinder river. The studies were carried out to assess the efficacy of the reservoir acting as the desilting basin. These studies were carried out for suspended sediment concentration of 3500 ppm maintaining the FRL and MDDL and for prototype discharges of 300, 500 and 700 m^3/s. The results indicated that the reservoir is acting as a desilting basin. The studies for reservoir flushing were carried out on physical model by reproducing the sedimentation profile obtained by mathematical model studies. The flushing studies were carried for the discharges 200, 300, 500 and 700 m^3/s and durations of 0-12 and 0-24 hours to optimize the flushing operations. The volume of sediment flushed in 12 hours was 0.008 and 0.011 Mm^3 for the discharge of 300 and 500 m^3/s respectively. Hence, it can be observed that reservoir capacity can be recouped with annual flushing during peak flows.

View from dam to 600 m upstream

5175-HYDRAULIC MODEL STUDIES FOR ASSESSMENT OF SCOUR DOWNSTREAM OF SALMA DAM SPILLWAY, AFGHANISTHAN, 1:55 SCALE 3-D COMPREHENSIVE MODEL

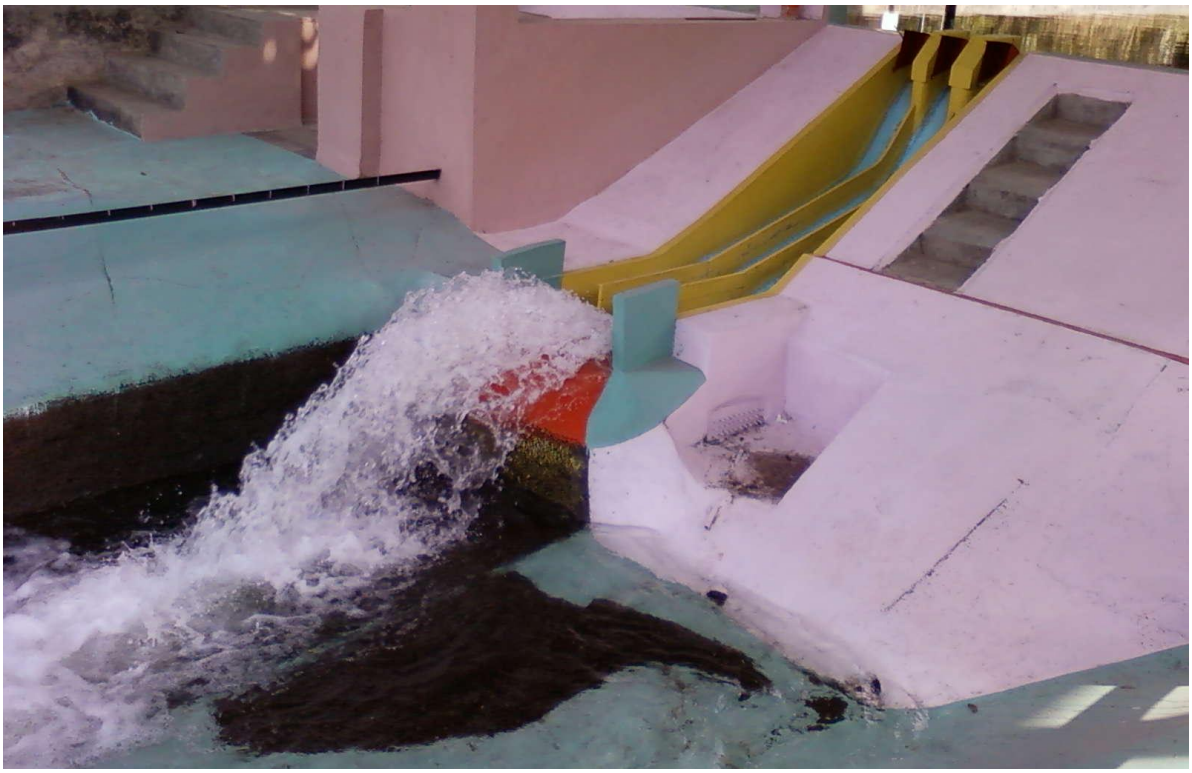
The Salma dam project is located near Chist-e-Sharif in Herat Province in Afghanistan. It is a multi-purpose project on river Hari Rud. The project envisages hydropower generation with an installed capacity of 42 MW (three units of 14 MW each) and irrigation of 75,000 hectares. A 107.5 m earth and rock fill dam would be constructed to divert flow towards powerhouse located on the right bank downstream of dam. The spillway is located on the right bank. The spillway consists of three spans of 8 m wide separated by 2 piers 7 m and 5 m thick and equipped with 11.17 m high radial gates. The design maximum discharge is 2,100 m^3/s. The MWL and FRL are at El. 1645.84 m and 1643.5 m respectively. The spillway has been provided with ski-jump bucket as energy dissipator. The irrigation sluice with sill at El. 1587 m passes through 5 m thick pier and opens on the spillway chute and carries discharge of 15 m^3/s. The power intake with sill level at El.1591.91 m passes through 7 m thick pier and carries 61 m^3/s discharge to the power house.

Earlier, hydraulic model studies were conducted for the original design, revised design of spillway and partial gate operation and reported vide Technical Report No. 4380 of October 2006, No. 4434 of March 2007 and 4639 of June 2009 respectively.

Present hydraulic model studies were conducted to assess the depth of scour downstream of spillway and location of preformed plunge pool. In the existing 1:55 scale geometrically similar 3-D comprehensive model, the river portion downstream of spillway from chainage 190 m up to chainage 350 m downstream of dam axis was reproduced with cohesionless erodible material (sand) of mean size (d_{50}) of about 2 mm for assessing the maximum depth of scour and scour pattern for various discharges.

It was observed from studies that the deepest scour reached up to El. 1516.3 m at chainage 300 m downstream of dam axis for design discharge of 2100 m^3/s passed with ungated operation. While passing discharge of 1643 m^3/s, with gated and ungated operation, the scour reached up to El. 1525 m and El. 1530 m respectively, at chainage 290 m downstream of dam axis. While passing discharge of 1643 m^3/s through left and centre spans at RWL El. 1645.8 m, the depth of scour would be at El. 1526.2 m. While passing discharge of 1050 m^3/s (50% of PMF) , maximum scour elevation of El. 1539 m was observed at chainage 230 m. Photos 1 & 2 show the flow conditions and scour downstream of spillway respectively while passing discharge of 1643 m^3/s (FRL El. 1643.5 m, Gated).

As scour can endanger the stability of excavated hill slopes and structure due to undermining, the plunge pool can be concrete lined which can absorb high energy impact of the jet. The concrete lining and the joints between the concrete panels may be subjected to considerable hydrodynamic uplift pressures. These concrete panel lining need to be properly anchored to the rock to avoid large displacements, or even rupture of the lining.



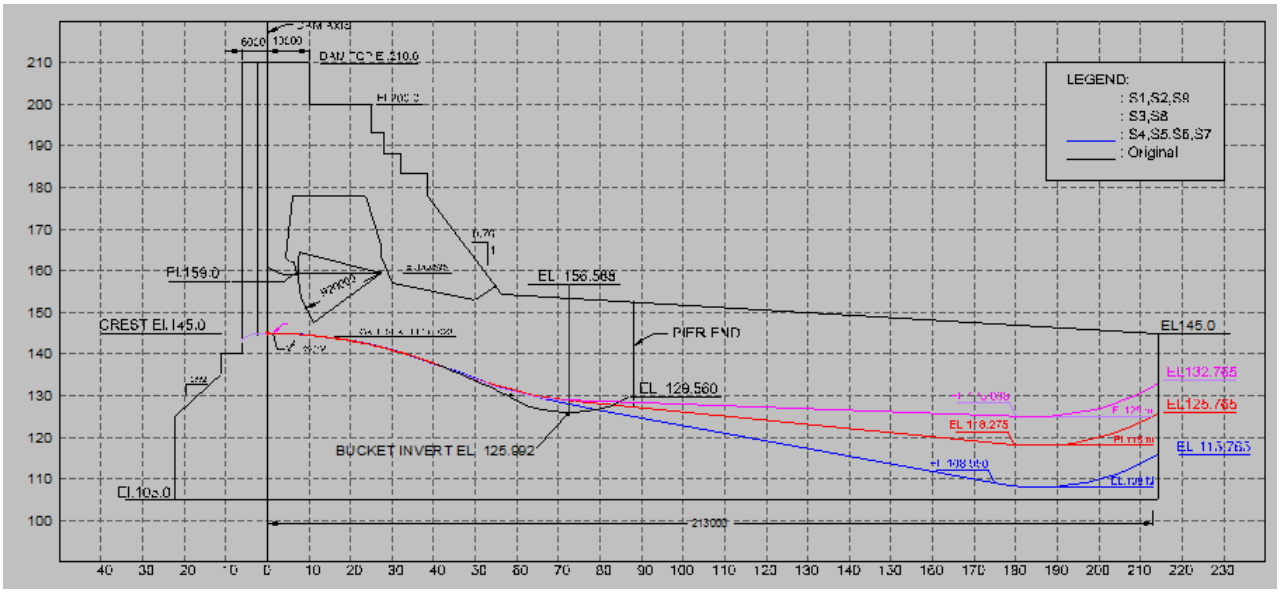
Flow conditions downstream of spillway, Q= 1643 m^3/s (FRL El. 1643.5 m, Gated)

Scour downstream of spillway, Q= 1643 m^3/s (FRL El. 1643.5 m, Gated)

5187-HYDRAULIC MODEL STUDIES OF EXTENDED SKI-JUMP BUCKET FOR SPILLWAY OF SUBANSIRI LOWER DAM, ARUNACHAL PRADESH / ASSAM,1:90 SCALE 3-D COMPREHENSIVE MODEL

Subansiri Lower Project envisages construction of a 116 m high above river bed level and 271 m long concrete gravity dam across river Subansiri to generate 2000 MW (8 units of 250 MW each) of power using 91 m gross head. It is located on river Subansiri on the border of the states of Arunachal Pradesh and Assam. It is the lower most project in the cascade of run-of-the-river schemes to tap the potential of the mighty Subansiri River. The spillway consists of 9 spans 11.5 m (W) x 14.0 m (H) with breast walls and crest at El. 145 m. The spillway is designed for a maximum outflow flood of 35,000 m^3/s at MWL El. 208.25 m. Hydraulic model studies for spillway and energy dissipator for Subansiri lower dam spillway have been in progress in CWPRS since 2002. Extensive studies were conducted for evolving economic and efficient hydraulic design of spillway and energy dissipator. In addition to original design of energy dissipator, stilling basin with apron elevation at El. 85 m and El. 94 m were studied and reported, as suggested by the Technical Expert Committee (TEC) set up by Planning Commission on Subansiri Lower H.E. Project. Later, Dam Design Review Panel (DDRP), headed by Chairman, CWC reviewed all the studies and recommended to study modified extended ski jump bucket spillway comprising three different spillway sections with different ski jump buckets for the 9 spans of spillway.

The existing 1:90 scale 3-D model was modified with extended ski-jump buckets as per DDRP proposal. The model included river reach up to 800m upstream and 1000 m downstream of dam axis, the power intake and tail pool. DDRP has recommended to design energy dissipation arrangement for 50% of design discharge, i.e. 17,500 m3/s. Studies indicated that performance of EDA was satisfactory while passing discharge ranging from 6000 m3/s to 9,000 m3/s through central spans (S4-S7) and upto 17,000 m3/s passing through spans S3-S8. While passing the discharge of 17,500 m3/s and above, through all spans equally and partially, the performance of EDA was not satisfactory as the width of plunge pool was not adequate to accommodate the ski-jump jets issuing from end spans. The model was modified to incorporate the super elevation of 1.0 m and 0.5 m in spans S1-S2 and S9 respectively. There was no effect of super elevation due to high velocity thick jets. It was mutually decided to provide the curved training walls with 25 m long, 12O deflector & 10 m long 5O deflector and 3.0 m and 1 m super elevation respectively in left and right end spans. The performance of spillway was tested for entire range of discharges varying from 6,000 m3/s up to 35,000 m3/s for RWL El. 190 m and FRL El 205 m. It was observed that while passing discharge of 17,500 m3/s through all spans, the left jet could be seen impinging just on left edge of plunge pool. It was suggested to increase curvature of deflector from 12O to 16O. It was observed that the water jet remains well below the training wall for discharges of 17,500 m3/s and below. For discharges of 26,250 m3/s and above the jet was hitting the upstream vertical face of deflector. Pulsating rooster tails could be seen at the end of divide walls. It is suggested to provide necessary protection to protect left bank and connect the deflector wall and training wall by slope to avoid splashing of jet on raised vertical face of deflector wall.



Cross section of modified extended ski jump bucket spillway comprising three different spillway sections

Performance of EDA for Q =17,500 m^3/s operating at FRL El. 205 m

5209- HYDRAULIC MODEL STUDIES FOR DESILTING CHAMBER FOR MANGDECHHU H.E. PROJECT, BHUTAN

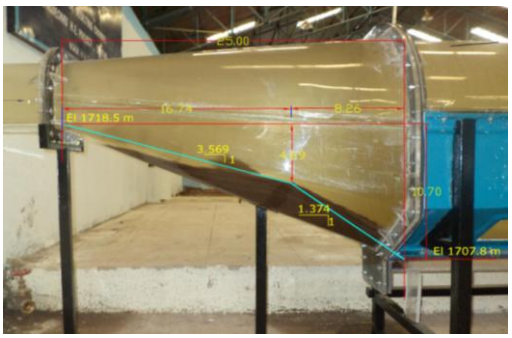
The Mangdechhu H.E. Project is located on River Mangdechhu in Trongsa Dzongkhag district in Central Bhutan. The installed capacity of the project would be 720 MW (4 units x 180 MW each) and would utilize gross head of 733 m. It will consist of a 114 m high (from deepest foundation level) concrete gravity dam to divert a river flow of 135.7 m^3/s (67.85 m^3/s per intake x two Nos.) into a 13.56 km long, 6.5 m diameter horse shoe shaped concrete lined Head Race Tunnel (HRT) through the two units of desilting chambers. The proposed size of each unit of the desilting chamber is 300 m (L) x 14 m (W) x 17.7 m (D). The desilting chambers have been proposed to remove suspended sediment particles coarser than 0.2 mm size and maximum sediment concentration of 5000 ppm. Design discharge for each chamber is 59 m^3/s and flushing discharge is 8.85 m^3/s. The model with original proposal was constructed to the scale of 1:25 G.S. The view of model is shown in photo 1.

It was concluded that desilting chamber of proposed size is adequate for 90% settlement of sediment having 0.2 mm diameter and above. The size of the flushing tunnel below the desilting chamber was found to be adequate in drawing the required flushing discharge for efficient transport of the sediment deposited in the desilting chamber. The performance of the outlet transition was found to be satisfactory. The size of settling trench is adequate to accommodate the dunes formed between successive openings and the openings provided in the model for flushing the settled sediment were working efficiently. The above findings were reported to project authorities vide CWPRS Technical Report No. 5121 of December, 2013 besides recommending modifications in inlet transition having bed slope of 1: 2.33. It was proposed that two different bed slopes of 1: 3.569 for upstream length of 16.74 m and 1: 1.374 for the remaining length of 8.26 m may be provided as shown in photo 2.

The inlet transition incorporating these modifications was re-fabricated and installed on the model as shown in photo 3 and further studies were conducted.

The modified inlet transition with twin bed slope is adequate for desired flow diffusion and efficient transport of sediment. With modified inlet transition, the settling efficiency of particle size of 0.2 mm and above works out to be 91% achieving slight improvement in settling efficiency of desilting chamber.

View of desilting Chamber



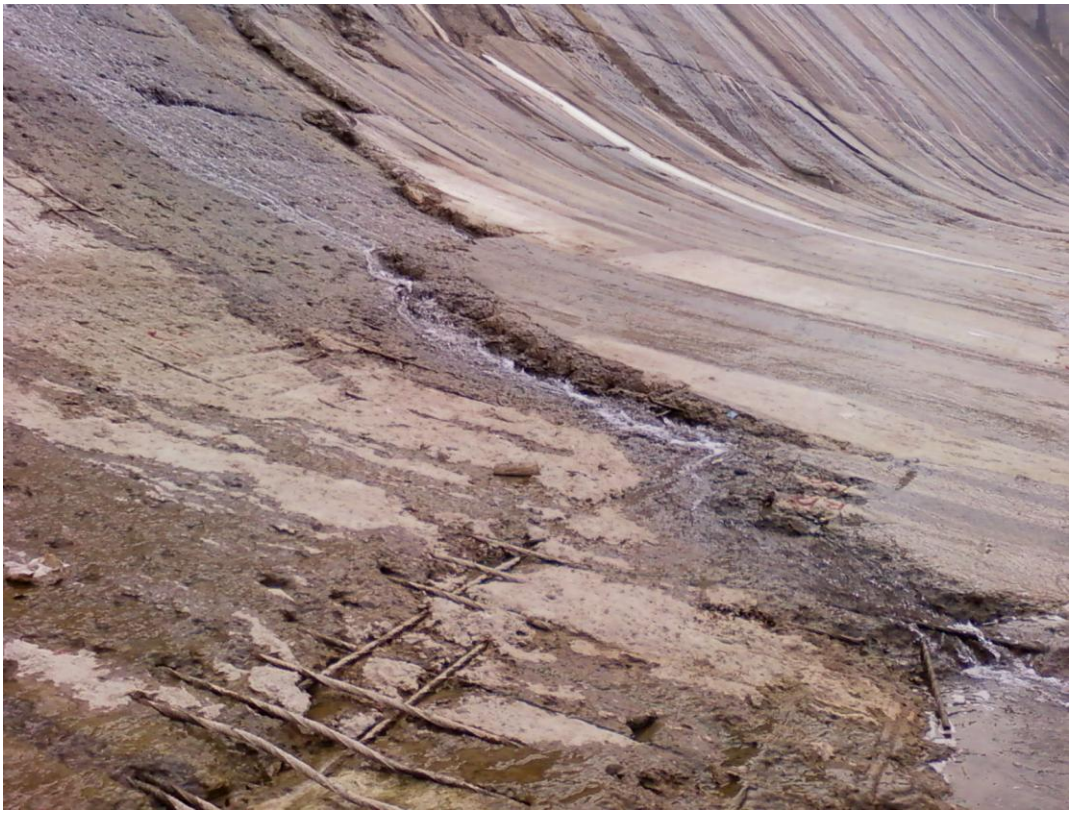
Proposed modifications for inlet transition

Modified inlet transition during studies

5223-HINDCASTING STUDIES FOR ASSESSING THE PERFORMANCE OF SPILLWAY AND ENERGY DISSIPATOR, INDIRA SAGAR DAM, MADHYA PRADESH

Indira Sagar Project (ISP) is situated on River Narmada, 10 Km from village Punasa in Khandwa district of Madhya Pradesh. ISP is a multipurpose Project with an installed capacity of 1000 MW and provides irrigation benefits to about 2.7 hactares of land annually. Total Catchment Area at the Dam site is 61642 Sq.Km. ISP is the mother project for the downstream projects on Narmada Basin with largest reservoir in India, having 12.22 BCM storage capacity. Indira Sagar dam is a solid gravity dam 653 m long and 92 m high, with curved dam axis having radius of 880 m. Main spillway comprises of 12 spans of 20 m x 17 m and auxiliary spillway comprises of 8 spans of 20 m x 17 m and are designed to dispose off a PMF of 83,543 m^3/s (combined). The energy dissipators for both are in the form of slotted roller bucket with different bucket invert levels. A sub-surface power house is located on the right bank with installed capacity of 8 units of 125 MW each.

The General Manager (Technical), NHDC, Bhopal, requested CWPRS to undertake field visit along with CWC design engineers to evaluate the performance of energy dissipation arrangement, which has been getting recurring damages during every monsoon. During field visit, it was observed that the spillway glacis and slotted roller bucket of spillway have been damaged badly. The spillway glacis got damaged at number of locations and concrete surface eroded and reinforcement bars exposed. The reinforcement of divide walls was exposed. The teeth of the roller bucket were overturned and thrown away by the flood waters. Photos 1& 2 show the eroded spillway glacis and severity of damage occurred to bucket. From theoretical calculations and site observations it is concluded that the damage to the energy dissipation arrangement is due to both hydraulic as well as structural reasons. The spillway was operated continuously for several weeks during 2013 monsoon with high discharges of the order of 20,000-35,000 m^3/s. Deficient tail water levels during initial period of operation leading to ski action, generation of high hydrodynamic pressures during roller formation due to very high incoming velocities of the order of 35 m/s and negative pressures on the teeth, were few of the hydraulic parameters leading to damage to the bucket. During discussions with project engineers/ CWC design engineers, it was opined that physical hydraulic model studies are required to be taken up on a 2-D sectional model to verify the suitable alternative to the existing slotted roller bucket type of energy dissipator which would be a possible solution to the recurring problem with existing energy dissipation arrangement. Since the energy dissipator of the auxiliary spillway is in good condition, no change in the same is needed. Suitable Gate operation schedule must be evolved to enable energy dissipators of both spillways to perform efficiently. Studies on 3- D comprehensive model are required to finalize the same.



Damages occurred to spillway surface

Severity of damage caused to bucket

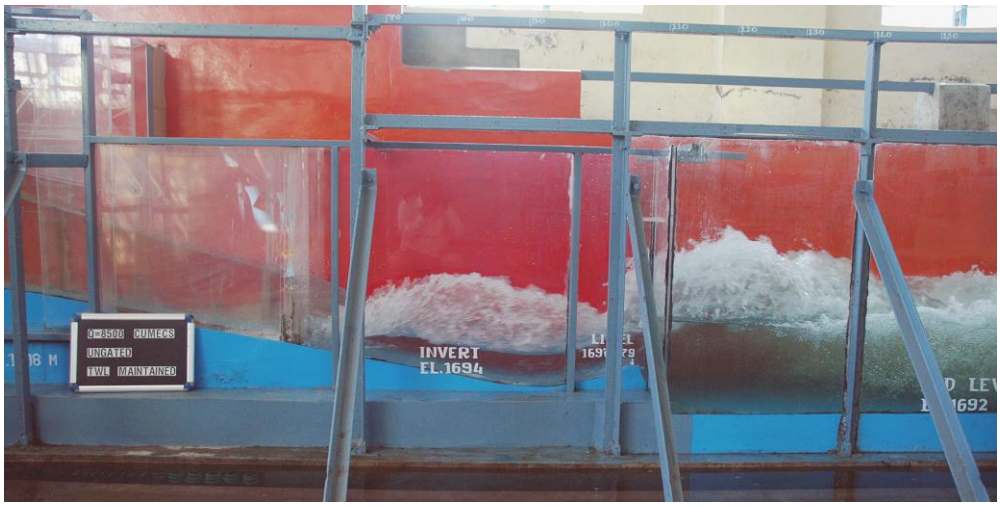
5224-HYDRAULIC MODEL STUDIES FOR MODIFIED DESIGN OF MANGDECHHU DAM SPILLWAY, BHUTAN, 1:40 SCALE 2-D SECTIONAL MODEL

The proposed Mangdechhu H.E. Project with installed capacity of 720 MW is a run of river scheme, located on river Mangdechhu, in Central Bhutan. The project envisages construction of a 141.28 m long and 56 m high concrete gravity dam above river bed. The dam has been provided with a breast wall spillway with 4 spans of 10 m wide x 16 m high, equipped with radial gates separated by 3.5 m thick twin piers. The revised crest level of the spillway is at El. 1708 m. The FRL is at El. 1747 m. The downstream profile conforms to equation $X^2 = 204\ Y$ and upstream profile conforms to equation $X^2/11652^2 + Y^2/6132^2 = 1$ The revised breast wall bottom profile conforms to the equation $X^2/32000^2 + Y^2/7000^2 = 1$.The spillway is required to pass a design discharge of 8500 m^3/s (SPF 4715 m^3/s + GLOF 3715 m^3/s) with one gate inoperative and to pass check flood of 10615 m^3/s comprising of PMF (6900 m^3/s) + GLOF(3715 m^3/s) with all gates operational. In the revised design a ski-jump bucket with 35 m radius, 25° lip angle and invert at El. 1694 m and lip at El 1698.279, is provided for energy dissipation. A 15 m long concrete apron has been provided downstream of the ski-jump bucket.

Hydraulic model studies were conducted on the original design of spillway. It was found that the performance of spillway was satisfactory in respect of discharging capacity and pressures over the spillway crest. It was suggested that the bottom profile of breast wall may be modified so that the flow adheres the profile for entire range of discharges and there by improving the discharging capacity of spillway. However the performance of ski-jump bucket was not found to be satisfactory, for the ungated operation of spillway as no ski-action was observed for any of the reservoir water levels. Therefore, it was suggested to raise the crest of the spillway to steeper the rear slope of spillway and modify the bucket. Accordingly, modified design was supplied by NHPC for model studies.

Hydraulic model studies were conducted on 1:40 scale 2-D sectional model for the modified design of the breast wall bottom profile, spillway and energy dissipator,to assess the performance of spillway in respect of discharging capacity, general flow conditions and performance of ski jump bucket for the entire range of discharges. It was observed that the design discharge of 8500 m^3/s could be passed at RWL El. 1733.6 m and a discharge of 12,000 m^3/s could be passed at FRL El. 1747 m with all gates fully open. With one span inoperative, a discharge of 9000 m^3/s could be passed at FRL El 1747 m. As such, the discharging capacity is found to be adequate. Water surface profile was observed along the centre line of spillway for the design discharge of 8500 m^3/s with all gates fully open. The trunnion axis of radial gates was well above the water surface profile. Hence, the trunnion elevation at El. 1724 m is found to be acceptable. With the modified bottom profile of the breast wall, it was observed that the water surface follows the breast wall bottom profile for the entire width of breast wall for the entire range of discharges for orifice flow. Photo 1 shows the flow conditions in the vicinity of the breast wall for a discharge of 12,500 m^3/s under ungated operation of the spillway at FRL. The hydrostatic pressure distribution on the revised breast wall bottom and spillway profile is acceptable as the pressures over the spillway profile and breast wall bottom profile are found to be positive for the entire range of discharges. Clear ski-action was observed for discharges up to 2125 m^3/s (25% of design discharge) for both gated and ungated operation of the spillway and for higher discharges submerged ski action was observed. Ski-action was taking place for both the gated and ungated operation of the spillway for all other discharges. Photo 2 shows the flow conditions over the spillway and energy dissipator for a discharge of 8500 m^3/s under ungated operation of the spillway.As such the modified design of ski-jump bucket shows satisfactory performance as compared to the original design. However, project authorities have informed that considering the sediment profile in front of the intake over a period of time, any rise in the spillway crest level beyond El. 1702 m may lead to choking of intake. Hence, raising of the crest level beyond El. 1702 m is ruled out. In view of this keeping the spillway design same as in the original design, modifications to the original design of energy dissipator have been proposed. Further studies have been taken up on a 3D comprehensive model.

Flow conditions in the vicinity of the breast wall
(Q = 12000 m^3/s at FRL El. 1747 m with ungated operation of spillway)

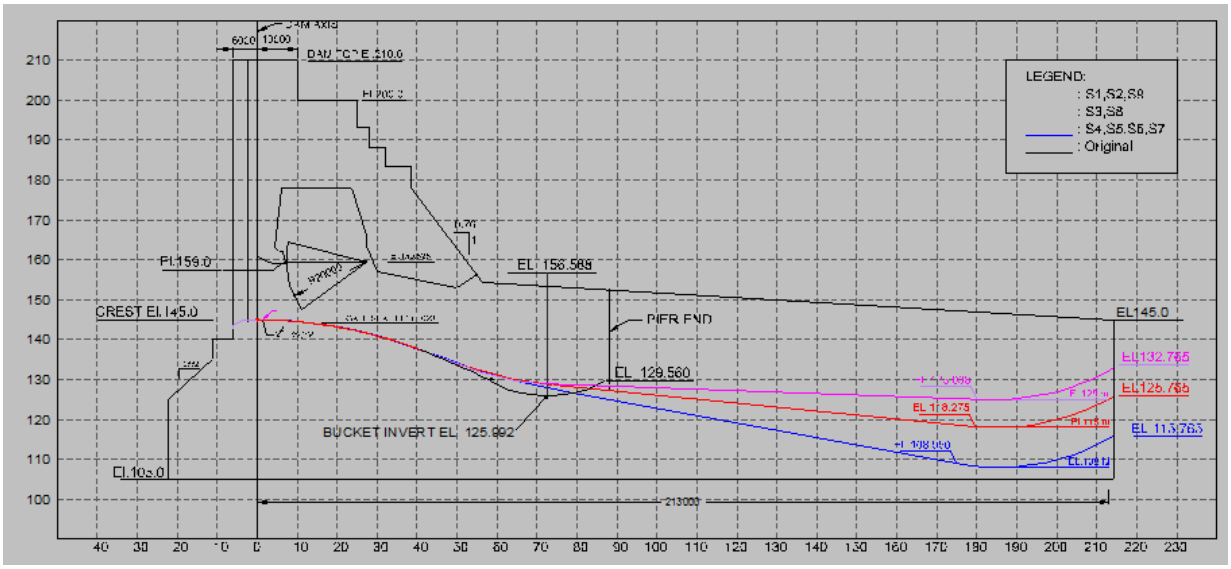


Flow conditions over the spillway and energy dissipator
(Q = 8500 m^3/s, Ungated operation of spillway)

5225-HYDRAULIC MODEL STUDIES OF EXTENDED SKI-JUMP BUCKET FOR SPILLWAY OF SUBANSIRI LOWER DAM, ARUNACHAL PRADESH / ASSAM, 1:70 SCALE 2-D SECTIONAL MODEL

Subansiri Lower Project envisages construction of a 116 m high above river bed level and 271 m long concrete gravity dam across river Subansiri to generate 2000 MW (8 units of 250 MW each) of power using 91 m gross head. It is located on river Subansiri on the border of the states of Arunachal Pradesh and Assam. It is the lower most project in the cascade of run-of-the-river schemes to tap the potential of the mighty Subansiri River. The spillway consists of 9 spans 11.5 m (W) x 14.0 m (H) with breast walls and crest at El. 145 m. The spillway is designed for a maximum outflow flood of 35,000 m^3/s at MWL El. 208.25 m. Hydraulic model studies for spillway and energy dissipator for Subansiri lower dam spillway have been in progress in CWPRS since 2002. Extensive studies were conducted for evolving economic and efficient hydraulic design of spillway and energy dissipator. In addition to original design of energy dissipater in the form of skijump bucket, stilling basin with apron elevation at El. 85 m and El. 94 m were studied and reported, as suggested by the Technical Expert Committee (TEC) set up by Planning Commission on Subansiri Lower H.E. Project. Later, Dam Design Review Panel (DDRP), headed by Chairman, CWC reviewed all the studies and recommended to study modified extended ski jump bucket spillway comprising three different spillway sections with different ski jump buckets for the spillway. Figure 1 shows cross section of modified extended ski jump bucket spillway comprising three different spillway sections.

A 2-D sectional model was constructed to a geometrically similar scale of 1:70 in a glass sided flume, comprising four full spans representing all the three different ski jump bucket profiles - S3 (representing spans S3 & S8), S4 & S7 (representing profiles of S4-S7) and S9 (representing profiles of S1-S2 & S9). Photo 1 show the side view and downstream view of the dry model. Though DDRP has recommended to design energy dissipation arrangement for 50% of design discharge, i.e. 17,500 m^3/s, studies were conducted for entire range of discharges. Studies indicated that negative pressures were occurring on spillway profiles of S3- S8. They were of the order of – 1.1 to – 2.5 m (cavitation index 0.13 to 0.10) predominant at chainages of 14 to 40 m and also further downstream necessitating provision of aerator(s). But on S9 profile, pressures were positive for entire range of discharges. Proper ski jump was forming for all the discharge conditions experimented for given tail water levels. The heights of training walls for different bays may be suitably designed based on the shown water surface profiles, according to the frequency of occurrence of floods. The rooster tails are forming due to interaction of jets in the bays. These were minor to very strong for increase in discharge. The maximum and minimum throw distances from the bucket lip were 130 m for 35000 m^3/s at FRL EL 205 m and 77 m for 2500 m^3/s at RWL El 190 m. Studies on 1: 25 scale geometrically similar scale model for aerator are in progress. Photo 1 shows performance of skijump bucket for Q = 35,000 m^3/s operating at FRL El. 205 m.



Cross section of modified extended ski jump bucket spillway comprising three different spillway sections

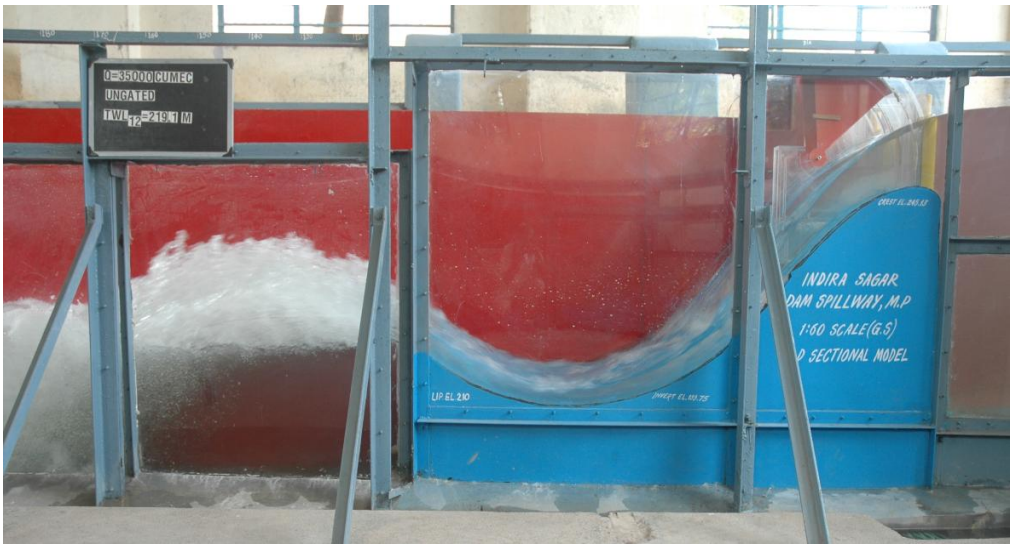
Performance of Ski jump bucket for Q =35,000 m^3/s at FRL El. 205 m

5228-HYDRAULIC MODEL STUDIES FOR INDIRA SAGAR DAM SPILLWAY, M. P. 1:60 SCALE 2-D SECTIONAL MODEL

Indira Sagar Project (ISP) is situated on River Narmada, 10 km from village Punasa in Khandwa district of Madhya Pradesh. ISP is a multipurpose Project with an installed capacity of 1000 MW and provides irrigation benefits to about 1.23 hectares. Indira Sagar dam is a 653 m long and 92 m high gravity dam, with curved dam axis having radius of 880 m. Main and auxiliary spillway comprise of 12 and 8 spans respectively of size 20 m x 17 m and are designed to dispose off a PMF of 83,400 m^3/s. The energy dissipator is in the form of slotted roller bucket with different bucket invert levels for both the spillways. The surface Power House is situated on the right bank of the river to house 8 Francis turbines of 125 MW each. The project is in operation since 2004-2005. It is observed by the project authorities that during every monsoon, the slotted roller bucket of the main spillway gets damaged and needs to be restored. Discharges of the magnitude of 30,000 m^3/s were released for a considerable time during the monsoon of 2013 and it was observed that the entire slotted roller bucket in front of spans 6 to 12 was washed off. A joint site visit of CWPRS and CWC officers was arranged by the project authorities to inspect and assess the possible reasons for the damage of energy dissipator and suggest remedial measures. A ski jump type of energy dissipator was proposed in place of slotted roller bucket for the main spillway considering the prevailing site conditions, hydraulic, structural and economic aspects. The ski-jump bucket with bucket radius 50 m, invert El.199.75 m and lip at El. 210 m was designed by CWC in consultation with CWPRS. Hydraulic model studies on a sectional model were required for assessing the performance of proposed ski-jump bucket and finalizing the design of the same.

A 2-D sectional model was constructed to a geometrically similar scale of 1:60 in a glass sided flume. One full and two half spans with two full piers along with ski-jump bucket were incorporated in the model. Hydraulic model studies were conducted to assess the performance of main spillway in respect of discharging capacity, water and pressure profiles and efficacy of ski-jump bucket for the entire range of discharges. A discharge of 35,537 m^3/s could be passed at FRL El. 262.13 m and a discharge of 38,896 m^3/s could be passed at MWL El. 263.25 m with all 12 spans of main spillway fully open. The water surface profile was also not overtopping the training walls. Therefore, the heights of both the training walls were sufficient in order to contain the flow. There was a rise in pressure over the ramp of the aerator followed by a sudden drop in pressure due to the cavity formed downstream of aerator. The zone of impact was generally between chainage 40-50 m just upstream of start of bucket. Isolated negative pressures of the order of -0.03 to -1.75 m are observed at the inlet to the bucket and the corresponding cavitation index is in the vicinity of critical cavitation index of 0.2. Also, this region is aerated from the air entrained jet from the aerator. Hence, there is no possibility of cavitation. Clear ski action was observed for discharges up to 17,769 m^3/s (50%) for gated and ungated operation of the spillway. Submerged ski action was observed for discharges beyond 17,769 m^3/s. The throw distances were found to be varying between 52 m to 72 m for the ungated and gated operation of spillway. Thus, the performance of spillway and ski jump bucket was satisfactory. A 15 m wide concrete apron has been recommended downstream of ski jump bucket with end key firmly anchored to the fresh rock to prevent undermining of the spillway toe due to cascading flows. Photos 1 and 2 show performance of spillway for Q = 17,769 m^3/s and 35,537 m^3/s for gated and ungated operation of spillway respectively.

Flow condition for gated operation of main spillway
Q=17769 m^3/s (50%) at FRL El. 262.13 m



Flow condition for ungated operation of main spillway
Q=35537 m^3/s (100%) at FRL El. 262.13 m

5232-HYDRAULIC MODEL STUDIES FOR DESILTING CHAMBER FOR PUNATSANGCHHU - II H.E. PROJECT, BHUTAN

The Punatsangchhu- II H.E. Project is located on River Punatsangchhu (called Sankosh in India) in Wangdue Phodrang Dzongkhag district in Western Bhutan. The installed capacity of the project would be 1020 MW (8 units of Francis turbines each 127.5 MW) and would utilize design head of 236 m. It will consist of a 136 m high concrete gravity dam to divert a river flow of 462.65 m^3/s through four intakes, 11.5 km long head race tunnels (HRT) through the four units of desilting chambers. The proposed size of each unit of the desilting chamber is 420 m (L) x 19 m (W) x 24.7 m (D). The desilting chambers have been proposed to remove suspended sediment particles coarser than 0.2 mm size and maximum sediment concentration of 4000 ppm. Design discharge for each chamber is 138 m^3/s and flushing discharge is 23 m^3/s. Considering the suspended sediment data supplied by M/S WAPCOS for the years 1992 to 2006 for the river Punatsangchhu at Wangdi rapids, the percentages of coarse and medium sediment have been worked out to be 31% whereas fine particle is 69%. The model was constructed to a scale of 1:35 G.S., view of the same is shown in photo.

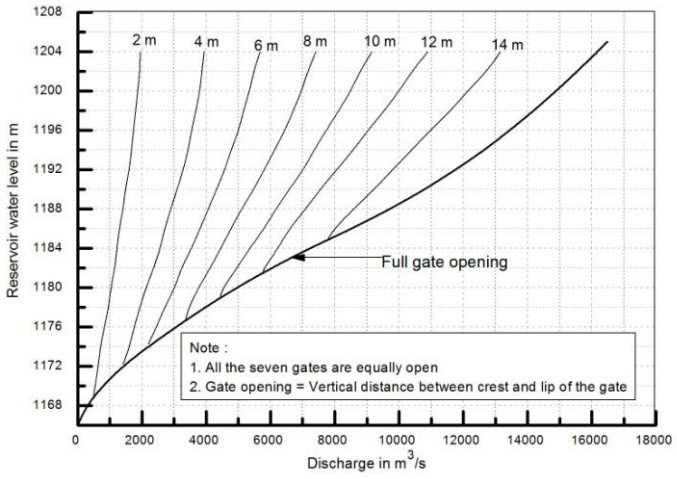
Overall view of model

5233-HYDRAULIC MODEL STUDIES FOR DISCHARGING CAPACITY OF FULL AND PARTIAL GATE OPERATION OF PUNATSANGCHHU - I DAM SPILLWAY, BHUTAN, 1:50 SCALE 2-D SECTIONAL MODEL

The Punatsangchhu - I H.E. Project is under construction as a run-of-river scheme on the Punatsangchhu River in Wangdue Phodrang district of western Bhutan. The project is located in a gorge about 7.0 km downstream of the Wangdue Bridge. The project envisages construction of a 136 m high and 279 m long concrete gravity diversion dam with top El. 205 m. The sluice spillway has been provided to pass a flood discharge (PMF) of 11,500 m^3/s along with Glacial Lake Outburst Flood (GLOF) of 4,300 m^3/s through 7 orifice openings of size 8 m wide x 15 m high with crest level at El. 1166 m. The FRL/MWL has been fixed at El. 1202 m and MDDL at El. 1195 m. Radial gates have been provided at the downstream face of breastwall for controlling the outflow discharge. The ski-jump bucket with pre-formed plunge pool is provided for energy dissipation. Besides sluice spillway, an auxiliary spillway bay has been provided with crest El. 1198 m for passing floating debris.

The four power intakes of 6.0 m Ø are located on the left bank to carry a design discharge of 115.662 m^3/s per intake. The water conductor system consists of a 9.07 km long, 10.0 m Ø D-shaped concrete lined head race tunnel leading to a 128.5 m high surge shaft of 24.5 m Ø. Two pressure shafts of 6.0 m Ø, 433 m long take off from surge shaft and trifurcate into three branches, which feed to individual turbines of capacity of 200 MW (6 units of 200 MW each) installed in an underground powerhouse.

Hydraulic model studies were conducted for the original design of spillway on 1:50 scale 2-D sectional model. Based on the recommendations from studies on original design, the breastwall profile was modified conforming to equation $X^2/40^2 + Y^2/8^2 = 1$ to improve the discharging capacity of spillway. Based on studies on 1:70 scale 3-D comprehensive model, the ski-jump bucket was raised by 9 m incorporating bucket radius of 45 m, exit angle of 35°, bucket invert at El. 1148.862 m and the lip at El. 1157 to improve the performance of energy dissipator. Hydraulic model studies were conducted on 1:50 scale 2-D sectional model for assessing discharging capacity of the breastwall spillway with partial and equal opening of all the gates for various water levels up to FRL El. 1202 m. The gate openings ranged from 2 m to 14 m. The partial gate opening was taken as the vertical distance of the gate lip above crest El. 1166 m. Discharging capacity curves giving discharges passed through the spillway with equal opening of all seven gates ranging from 2 m to 14 m are depicted in Figure-1 and tabulated the discharges passed through the spillway for various reservoir levels up to FRL El. 1202 m and gate openings. These results would be useful in planning the operation of spillway.

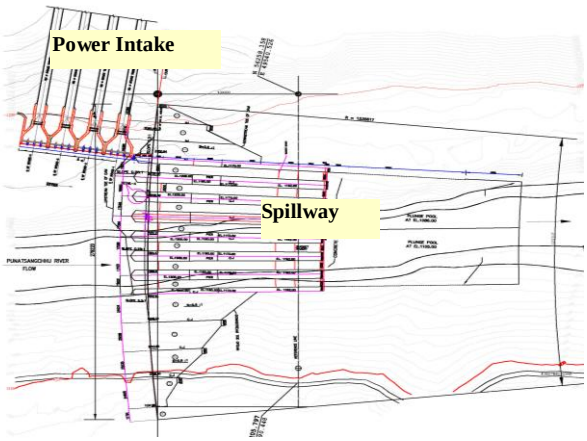


Discharging cpacity of spillway for full and partial gate operation

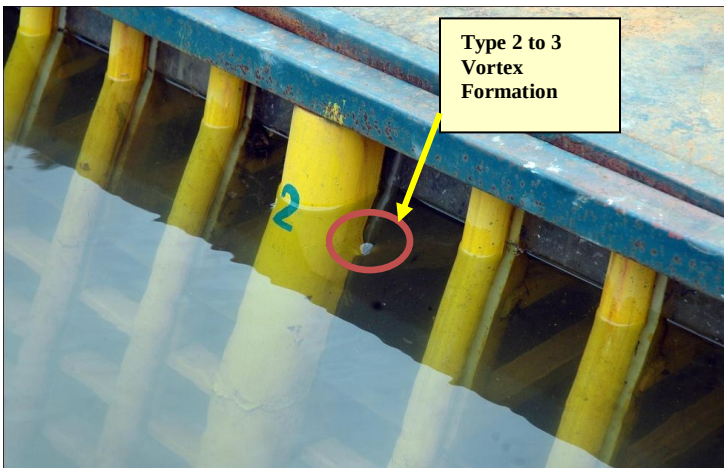
5235-HYDRAULIC MODEL STUDIES FOR POWER INTAKE OF PUNATSANGCHHU- I H.E. PROJCT, BHUTAN, 1:35 SCALE MODEL

Punatsangchhu hydro-electric project (Bhutan) is a run-of-the-river scheme envisages construction of a 130 m high and 239 m long (at the top) concrete gravity dam and an underground Power Station of 1200 MW capacity. The water conductor system for power generation consists of four numbers of intakes, one headrace tunnel, two numbers of pressure shafts, six numbers of penstocks, six Francis turbine units with design discharge of 64.26 m^3/s and gross operating head of 328 m. Figure 1 shows the layout plan of the water conductor system of project. Figures 2 show the general layout plan of the dam, spillway and power intakes.

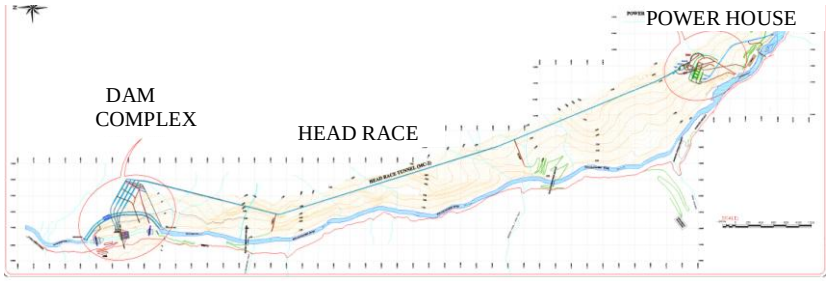
Hydraulic model studies were conducted in a 1:35 geometrically similar scale model to study the flow conditions in the reservoir in the vicinity of power intakes and to suggest remedial measures if air entraining vortex formation is occurring in front of power intakes. The studies were conducted for combination of operations of intakes and sluice spillways with discharge 2500 m^3/s at maximum draw down level (MDDL) and full reservoir level (FRL). Observations indicated occasional formation of vortices of type 2 i.e. surface swirl with nominal drop in water surface to type 3 i.e. dye core vortices without ingesting floating materials. Vortices formed due to flow separation from intake main piers. Photograph 1 shows the formation of vortex at intake. Small stagnation zone upstream of intake was observed. The coherent surface swirl and dye core vortices are not air- entraining vortices and therefore submergence provided at intake is adequate and anti-vortex devices are not required. The performance of intake with respect to flow conditions was found satisfactory.



General layout plan of the dam, spillway and power intakes



Formation of ***vortex at intake***



Layout plan of the water conductor system

5237-HYDRAULIC MODEL STUDIES FOR PUNATSANGCHHU - II DAM SPILLWAY, BHUTAN
1:50 SCALE 2-D SECTIONAL MODEL

The Punatsangchhu-II H.E. Project isa run-of-river scheme on the Punatsangchhu River in Wangdue Phodrang district of western Bhutan to generate 1020 MW (6 units of 170 MW each) of power installed in an underground powerhouse. The project is located downstream of Punatsangchhu- I H.E. Project in a gorge about 22.5 km downstream of the Wangdue bridge. All the project components are located on the right bank of the river except Diversion Tunnel which is located on the left bank. The project envisages construction of a 86 m high (from deepest foundation level) and 217.5 m long concrete gravity diversion dam with top El. 846 m. The sluice spillway has been provided to pass the design discharge of 16023 m^3/s (PMF of 11,723 m^3/s + Glacial Lake Outburst Flood (GLOF) of 4,300 m^3/s) through 7 orifice openings of size 8 m wide x 13.2 m high with crest level at El. 797 m. The FRL/MWL has been fixed at El. 843 m and MDDL at El. 825 m. Radial gates have been provided at the downstream face of breastwall for controlling the outflow discharge. A ski-jump bucket of 35 m radius and 35° lip angle with pre-formed plunge pool is provided for energy dissipation. Besides sluice spillway, an auxiliary spillway bay has been provided with crest El. 839 m for passing floating debris.

Hydraulic model studies were conducted for the original design of spillway on 1:50 scale 2-D sectional model for assessing the performance of spillway in respect of discharging capacity, water and pressure profiles, performance of ski- jump bucket for the entire range of discharges up design discharge of 16,023 m^3/s and reservoir water levels up to FRL/MWL El. 843 m. Studies indicated that the discharge of 17,010 m^3/s could be passed at FRL/MWL El. 843 m, with all 7 spans operating fully open as against the design discharge of 16,023 m^3/s. It was observed that design discharge 16,023 m^3/s could be passed at reservoir water level of El. 839.1 m through all 7 spans fully open. With one span inoperative, a discharge of 14,580 m^3/s could be passed which is more than the PMF discharge of 11,723 m^3/s at FRL/MWL El. 843 m. As such, discharging capacity of the spillway is considered to be adequate. The upper nappe of jet issuing from the sluice opening was seen adhering to the breastwall bottom profile for the orifice flow regime thus making the entire height of orifice fully effective for ungated operation of spillway. The trunnion axis of the radial gates was well above the water surface for all the discharges. Water was spilling over the training walls intermittently for discharges 8000 m^3/s (50% of design discharge) and above due to high TWL. The heights of training walls are to be suitably designed based on the water surface profiles, bulking of flow due to air entrainment in prototype and free board requirement. The hydrostatic pressure distributions on the spillway profile and breastwall bottom profile were found to be acceptable. The performance of ski-jump bucket was not satisfactory for entire range of discharges for gated and ungated operation of spillway as the bucket lip was getting submerged due to high tail water levels. Submerged ski action with aerated surface rollers (hydraulic jump) riding over the bottom jet could be seen in the bucket. It was suggested that the design of the bucket may be modified by raising the bucket lip by about 3 to 4 m so as to reduce the submergence depth due to tail water to improve the performance of Ski-jump bucket. Photos 1 and 2 show the performance of ski-jump bucket for the discharges of 4,006 m^3/s (25% of design discharge) and the design discharge of 16,023 m^3/s at FRL/MWL El. 843 m with gated operation of spillway.

Performance of ski-jump Bucket (Q= 4,006 m^3/s (25%), gated

Performance of ski-jump bucket (Q= 16,023 m^3/s (100%), gated

5241- HYDRAULIC MODEL STUDIES FOR TEESTA-IV DAM SPILLWAY, SIKKIM
1:60 SCALE 3-D COMPREHENSIVE MODEL

Teesta H. E. Project, Stage-IV is a run-of-the-river scheme located on River Teesta after its confluence with Runchu near New Jalpaiguri in Sikkim. The project is a part of the hydropower-rich Teesta cascade between Teesta-III project on the upstream and Teesta -V project on the downstream. The project envisages construction of 65 m high (from river bed level) and 197.2 m long concrete gravity dam with top El. 760 m. The breast wall spillway has been provided to pass the design flood of 13,000 m^3/s through 6 orifice openings of size 9 m wide x 14.5 m high with crest level at El. 716 m. The FRL has been fixed at El. 755 m and MDDL at El. 740 m. Radial gates have been provided at the downstream face of breastwall for controlling the outflow discharges. A ski-jump bucket of 35 m radius and 35^0 lip angle with invert at El. 697.0 m and pre-formed plunge pool is provided for energy dissipation. Four power intakes each of 6.5 m Ø with sill level at El. 726 m are located on the right bank to carry a design discharge of 480 m^3/s. The water conductor system consists of four desilting basins and two Head Race Tunnels leading to surge shafts of 23 m Ø. Two pressure shafts take off from surge shafts and bifurcate into two branches, which feed to individual Vertical Francis turbines of capacity of 130 MW. An underground powerhouse has been provided with an installed capacity of 520 MW.

Hydraulic model studies were conducted on 1:60 scale geometrically similar 3-D comprehensive model to assess the performance of spillway in respect of discharging capacity, water and pressure profiles and efficacy of ski-jump bucket for the entire range of discharges. A discharge of 15,360 m^3/s could be passed at FRL El. 755 m against the design discharge of 13,000 m^3/s with all the six spillway spans operating fully. The design maximum discharge of 13,000 m^3/s could be passed at El. 746.63 m through six spans fully open as against FRL El. 755.0 m. A discharge of 12,800 m^3/s could be passed with one span inoperative at FRL El. 755.0 m, which is 1.5% less than the design discharge of 13000 m^3/s. Hence, the discharging capacity of the spillway is found to be adequate. It was observed that the upper nappe of the jet was not following the breast wall bottom profile for entire range of reservoir water levels with orifice flow. Therefore, it is necessary to modify the bottom profile of the breast wall so as to make it effective as there is a scope for further improvement in the discharging capacity of spillway. The pressures on bottom profile of spillway were found to be acceptable. Submerged ski-action was observed for the discharges higher than 3250 m^3/s with gated and ungated operation of spillway. Clear ski-action was observed only for the discharges of 3250 m^3/s and lower with gated operation of spillway with reservoir water level at FRL El. 755 m. The flow was concentrated towards the right bank in the plunge pool and the jet issuing from the right end span was also hitting the right bank. It is suggested to tilt the dam axis by about 3 degree which would be beneficial in containing and guiding the ski-jump jet after the point of impingement towards the river course which is taking a left turn downstream of pre-formed plunge pool. Providing the curved dam axis in addition to tilting would improve the performance of ski-jump bucket and uniform flow distribution across the river valley downstream of spillway and would also economize to great extent the excavation of steep right bank required for providing pre-formed plunge pool. Mild vortices were observed in front of all the 4 units of power intake for the entire range of discharges with and without operation of spillway at MDDL El. 740 m. Therefore, it is felt that the design of the intake needs to be revised. Photos 1 and 2 show the performance of ski-jump bucket for 25% and 50% of design discharge with gated operation of spillway.

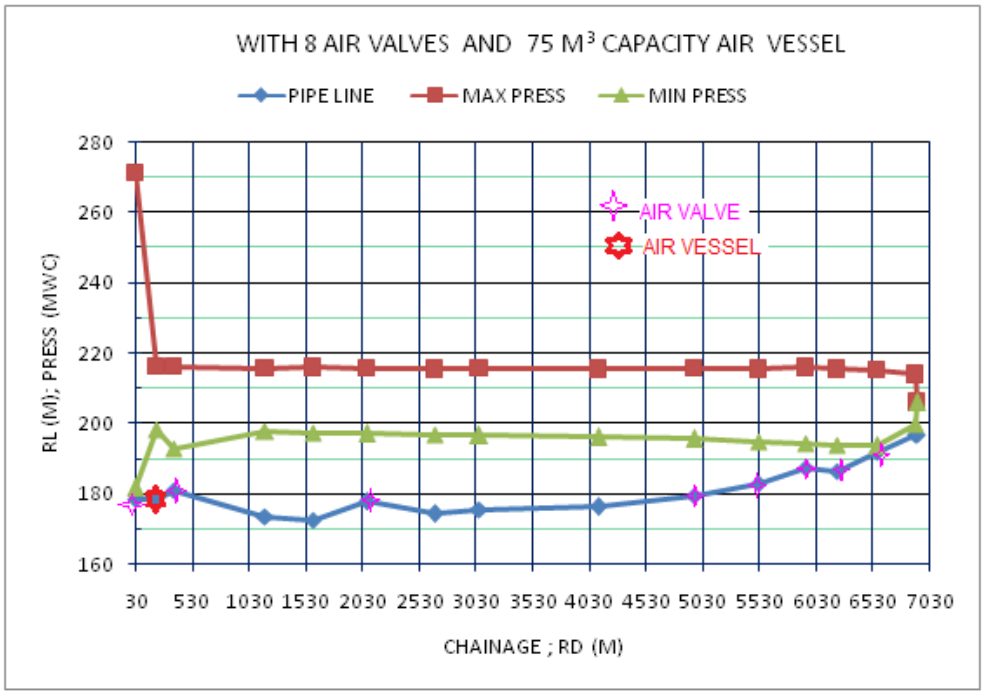
Performance of ski-jump Bucket for gated operation of spillway
Q=3250 m^3/s (25%) at FRL El. 755 m

Performance of ski-jump bucket for gated operation of spillway
Q=6500 m^3/s (50%) at FRL El. 755 m

5257-MATHEMATICAL MODEL STUDIES FOR SURGE ANALYSIS OF BORGHAT-I LIFT IRRIGATION SCHEME, TALUKA: MUL, DISTRICT: CHANDRAPUR, MAHARASTRA

The Borghat -I Lift Irrigation Scheme Project at Korambi, Taluka Mul; District: Chandrapur, Maharastra lifts water by pumping upto the first distribution point at 6.96 km away for the purpose of irrigation. An intake structure in the river Wainganga with three vertical turbine pumps lifts water through a system of manifold and a rising main of diameter 1300 mm and thickness 10 mm. During regular startup/shutdown, the predetermined closing time pattern of non return valve is followed to avoid water hammer. However, during sudden shutdown due to power failure, the pumps decelerate leading pressure fluctuations to cause water hammer as per rate of change of velocity. Thus, the pipeline is required to withstand maximum and minimum pressures.

Mathematical model studies were carried out to access maximum and minimum pressures on the rising mains. To protect the long pipeline of large diameter carrying huge flow from water hammer pressures safety devices like air valves and air vessel have been provided. The number of computer runs using numerical modeling through M. Hanif Chaudhry WH- 2.7 software was taken to optimize the use of air valves and capacity of air vessel to bring both the maximum and minimum water hammer pressures within safe design value of pipeline. Finally, air valves (8 Nos.) and air vessel of capacity 75 m^3 (1 No.) have been provided on rising mains. The water hammer analysis indicated the absolute maximum and minimum pressure of 43.44 and 3 mWC, respectively.

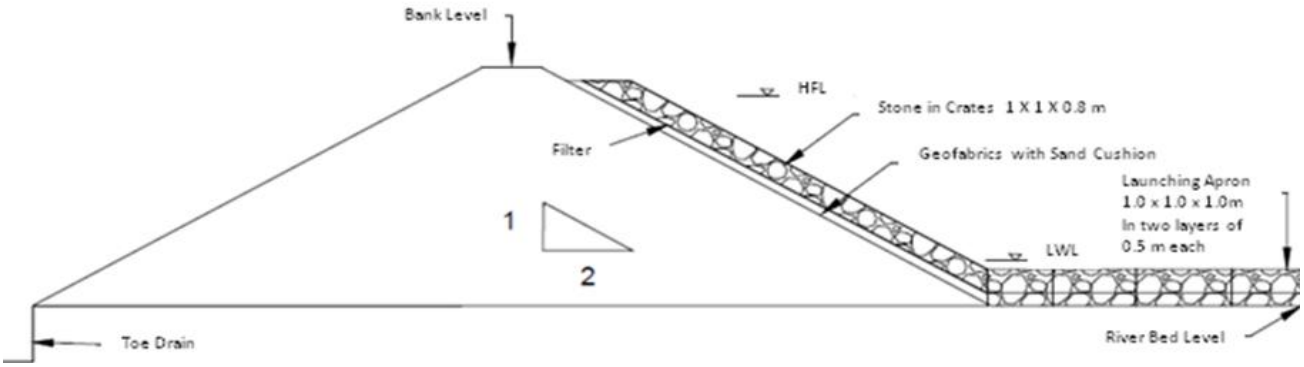


Surge analysis for Borghat -I LIS
Air Valves (8 nos.) and Air Vessel 75 m^3 capacity (1 no, at chainage 210 m)

5263-MATHEMATICAL MODEL STUDIES FOR FLOOD PROTECTION MEASURES OF JABBER KHAD, HIMACHAL PRADESH

The Jabber khad, a major tributary of Chakki khad in Kangra District of Himachal Pradesh experiences typical flashy floods during monsoon. The Jabber khad is fed by a number of streams carrying large quantity of sediment load which gets deposited resulting in aggradation of river bed. Jabber khad creates havoc during monsoon almost every year due to the floods. During the floods valuable agricultural land is either washed away or rendered unproductive due to sediment deposition over the fertile land. Hence, studies of flood protection works were carried out by CWPRS for deciding alignment and design of bank protection works. Since there are no existing rain gauge or river gauging stations in the catchment area of Jabber khad, design flood was estimated from rainfall-runoff data of hydro-meteorologically homogeneous catchments and Synthetic Unit Hydrograph (SUH) Technique as per the guidelines of CWC. Physiographic Parameters of the catchment of Jabber Khad were derived using GIS Techniques.

The SRTM DEM was processed using HEC-GeoHMS and ARC GIS software. HECRAS software was used to estimate the water surface profiles and other hydraulic parameters for the design of river protection measures. The levees are proposed on both banks with a side slope of 2H:1V. The river side of the levee should be protected with one layer of stone in crates of size 1.0 x 1.0 x 0.5 m laid above a geo-synthetic filter in upstream reach above confluence with Gareli Khad. In downstream reach slope protection in the form of stone crates of size 1 m x 1m x 0.8 m in one layer over geo-fabric filter is proposed. To protect toe of the embankment, launching apron is suggested. The launching apron would consist of two layers of stones in crates of size 1.0 m x 1.0 m x 0.4 m laid over geo-synthetic filter in upstream reach. The width of apron in upstream in reach is suggested to be 6.0 m. In downstream reach apron width of 7.5 m is proposed with stone crate of size 1 m x 1 m x 0.5 m laid over geo-fabric filter in two layer . A 150 mm thick layer of coarse sand should be laid over geo-synthetic filter to avoid fabric rupture during placement of stones.



Typical section of the levee along with slope protection

5264- CALIBRATION OF INTEGRATED GATE, DOPPLER AND TRANSIT-TIME ACOUSTIC FLOW METERS PROVIDED BY KBJNL, KARNATAKA, AT CWPRS MODEL CANAL

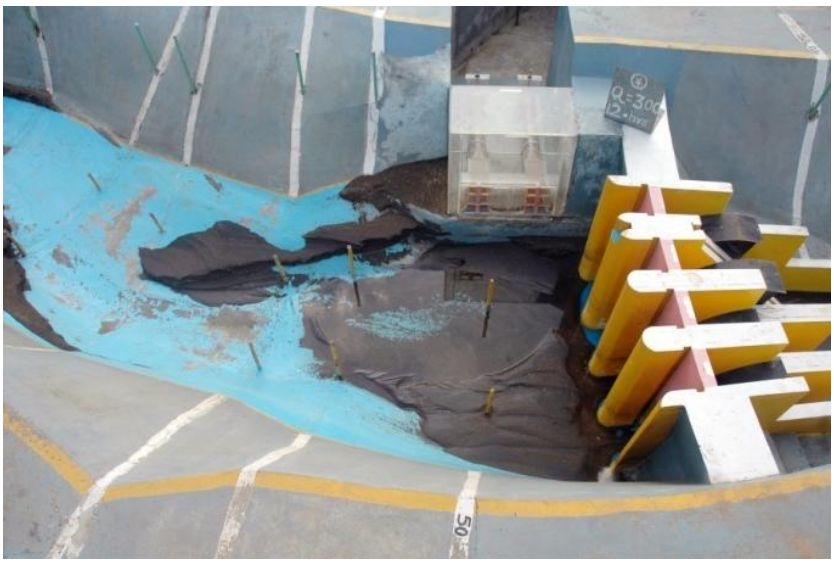
Krishna Bhagya Jal Nigam Limited (KBJNL), Govt. of Karnataka, is implementing extension, renovation and modernisation of Narayanpur Left Bank Canal (NLBC) with canal automation system as a pilot project by deploying automated integrated gates, digital flow and water level measurement devices and a communication network for operational integration of its various components through SCADA platform. KBJNL requested CWPRS to calibrate supplied integrated gate (Mechatronics), Doppler (Mace) and transit-time (Chetas) flow meters at rectangular (0.6m wide x 0.8m deep) CWPRS model canal. The model canal receives reference discharge through a sharp crested weir. Integrated gate has been installed at 19.50 m downstream of the sharp crested weir for establishing steady flow conditions for accurate flow measurement. Doppler type and transit-time flow meters were installed at 0.3 – 0.6 m upstream of integrated gate. A V-ADCP (Teledyne make) was deployed at downstream of gate to corroborate with reference discharge. A series of discharge measurements covering the range of integrated gate openings is made and a curve between percentage gate openings and coefficient of discharge is provided. The results for acoustic Doppler and transit-time discharge values are accurate with nearly 2 - 3% accuracy under controlled laboratory conditions. Acoustic flow meters are attractive for their accuracy, minimal head loss and ease in installation and SCADA compatible outputs.

5267-HYDRAULIC MODEL STUDIES FOR RESERVOIR FLUSHING, FOR MANGDECHHU HYDROELECTRIC PROJECT, BHUTAN

NHPC Ltd. has proposed to implement Mangdechhu H.E. project (720 MW) on Mangdechhu river, Bhutan. The project is planned as a run of the river scheme for providing peaking power. Since the project is based in the Himalayan region, live storage of the reservoir is likely to be filled with sediment in a short period. In order to restore the live storage, annual flushing of reservoir through low level sluice spillway is planned. A concrete gravity dam approximately 114 m high from the deepest foundation level and 56 m high above the riverbed having top EL 1750.00 m is proposed across Mangdechhu river near village Chunjapang. The full reservoir level (FRL) for the dam is at EL 1747.00 m and minimum draw down level (MDDL) at EL 1730.50 m. The length of the reservoir is about 800 m. The gross storage capacity of the reservoir at FRL is 2.128 Mm^3 and live storage between MDDL and FRL is 1.171 Mm^3.

The model of Mangdechhu Hydroelectric reservoir was constructed to a geometrically similar scale of 1:100 for the reach of Mangdechhu river from 825 m upstream to 200 m downstream of dam axis. The model was equipped with suitable inlet and outlet arrangements including discharge measurements. Reservoir flushing was simulated in the model with alternative intake alignment for various flushing discharges and durations. It was observed that for the lower flushing discharges of 100 and 150 m^3/s there is not much difference in quantity of sediment flushed beyond 12 hours of flushing. For the higher discharges of 200 to 300 m^3/s, the above condition was achieved in less than 12 hours of flushing.

Due to favourable site conditions for intake foundation, alternative in which the intake is aligned 10 m from spillway towards left bank was also simulated in the model. It was observed that there is no appreciable change in the sediment deposition pattern after flushing for alternative intake locations. The sediment deposition level in front of intake varies between EL 1710.00 to 1712.00 m. It was observed that for higher discharges 200 and 300 m^3/s there is not much increase in quantity of sediment flushed beyond 6 hours. Therefore it is suggested that, for optimum operation of the reservoir flushing with higher discharges may be carried out for 6 hours durations.



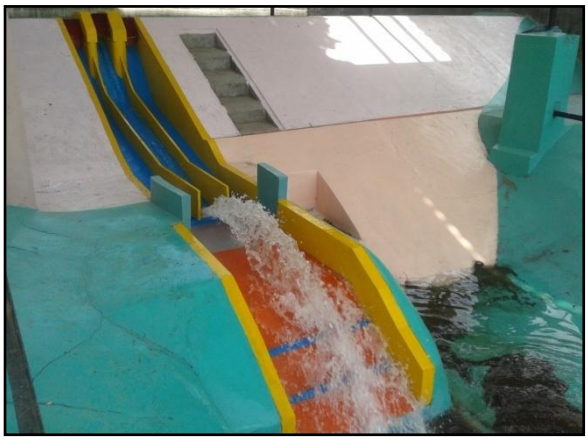
5268-HYDRAULIC MODEL STUDIES FOR ASSESSMENT OF SCOUR DOWNSTREAM OF SALMA DAM SPILLWAY, AFGHANISTHAN,1:55 SCALE 3-D COMPREHENSIVE MODEL

The Salma dam project is located near Chist-e-Sharif in Herat Province in Afghanistan. It is a multi-purpose project on river Hari Rud. The project envisages hydropower generation with an installed capacity of 42 MW (three units of 14 MW each) and irrigation of 75,000 hectares. A 107.5 m earth and rock fill dam would be constructed to divert flow towards powerhouse located on the right bank downstream of dam. The spillway is located on the right bank. The spillway consists of three spans of 8 m wide separated by 2 piers 7 m and 5 m thick and equipped with 11.17 m high radial gates. The design maximum discharge is 2,100 m^3/s and mean annual flow of 700 m^3/s. The MWL and FRL are at El. 1645.84 m and 1643.5 m respectively. The spillway has been provided with ski-jump bucket as energy dissipator. The irrigation sluice with sill at El. 1587 m passes through 5 m thick pier and opens on the spillway chute and carries discharge of 15 m^3/s. The power intake with sill level at El.1591.91 m passes through 7 m thick pier and carries 61 m^3/s discharge to the power house.

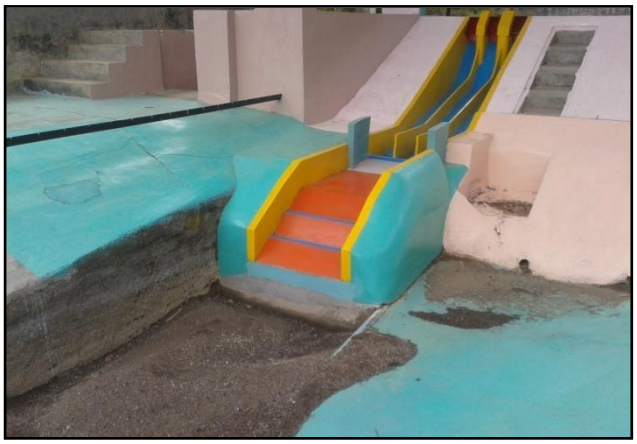
Earlier, scour studies for assessment of scour depth and location of plunge pool downstream of spillway were conducted on 1: 55 scale comprehensive model and findings of the studies were communicated vide report No. 5175 of April 2014. Additional studies were conducted at the request of Additional Chief Engineer, WAPCOS Ltd for assessment of scour depth at plunge pool location with the modified protection works comprising 23 m long RCC apron followed by concrete platform downstream of spillway (over NSL), up to pre-formed plunge pool having bed at El. 1541 m. Also, performance of ski jump jet over concrete lined apron and flow conditions on the concrete platform have been taken up for the modified design.

Water surface profiles indicated that for discharge of 525 m^3/s, the ski jump jet is falling on the concrete apron and cascading along the downstream concrete platform over NSL. For discharge of 1050 m^3/s passing through all three spans with ungated operation of spillway, the ski jump jet impacts on the horizontal portion of the concrete lined platform and cascades over the sloping portion leading to plunge pool. For discharge of 1050 m^3/s and above jet is impinging in the plunge pool.

Scour studies indicated that the deepest scour reached up to El. 1511.6 m at chainage 310 m downstream of dam axis for design discharge of 2100 m^3/s passed with ungated operation. The maximum scoured bed elevations observed for discharges 1643 m^3/s, 1200 m^3/s, 1050 m^3/s, 675 m^3/s and 525 m^3/s were El. 1528.54 m, El. 1528.27 m, El. 1534.92 m, El. 1537.23 m and El. 1543.12 m respectively. Photos 1 & 2 show the flow conditions and scour downstream of spillway respectively while passing discharge of 675 m^3/s (with one gate in operation, RWL El. 1643.5 m).



Flow conditions downstream of spillway, Q= 675 m^3/s (One gate in operation RWL El. 1643.5 m)

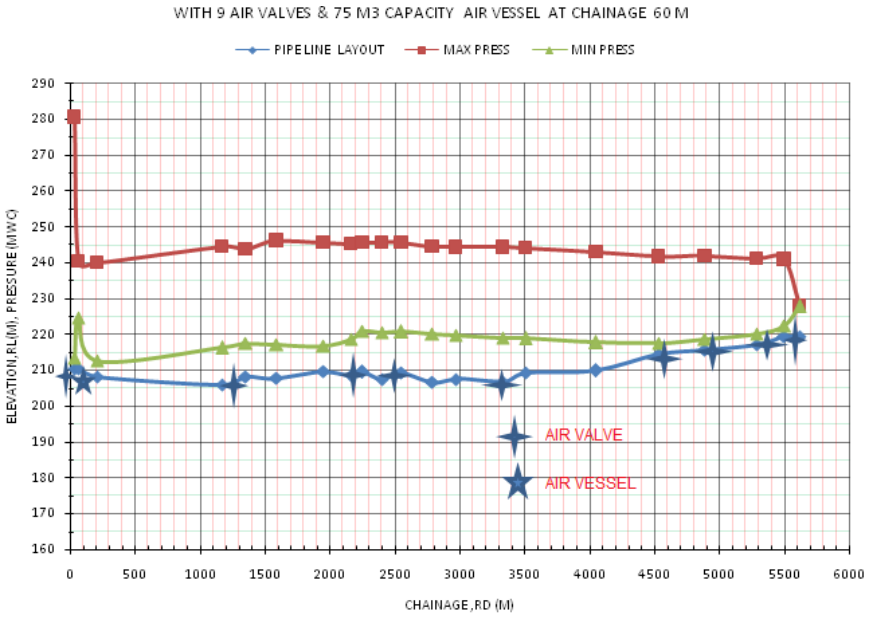


Scour downstream of spillway, Q= 675 m3/s (One gate in operation RWL El. 1643.5 m)

5276-MATHEMATICAL MODEL STUDIES FOR SURGE ANALYSIS OF DONGARGAON –THANEGAON LIFT IRRIGATION SCHEME, TALUKA: ARMORI, DISTRICT: GADCHIROLI, MAHARASTRA

The Dongargaon–Thanegaon lift irrigation scheme at Dongargaon, Taluka Armori; District: Gadchiroli, Maharastra lifts water by pumping upto the first distribution point at 5.62 km away for the purpose of irrigation. An intake structure in the river Wainganga with three vertical turbine pumps lifts water through a system of manifold and a rising main of diameter 940 mm and thickness 7 mm. During regular startup/shutdown, the predetermined closing time pattern of non return valve is followed to avoid water hammer. However, during sudden shutdown due to power failure, the pumps decelerate leading pressure fluctuations to cause water hammer as per rate of change of velocity. Thus, the pipeline is required to withstand maximum and minimum pressures.

Mathematical model studies were carried out to access maximum and minimum pressures on the rising mains. To protect the long pipeline of large diameter carrying huge flow from water hammer pressures safety devices like air valves and air vessel have been provided. The numbers of computer runs using mathematical modeling through M. Hanif Chaudhry WH- 2.7 software were taken to optimize the use of air valves and capacity of air vessel to bring both the maximum and minimum water hammer pressures within safe design value of pipeline. Finally, air valves (9 nos.) and air vessel of capacity 75 m^3 (1 no.) have been provided on rising mains. The water hammer analysis indicated the absolute maximum and minimum pressure of 38.14 and 3 mWC, respectively after the location of surge mitigating device viz. air vessel and air valves.

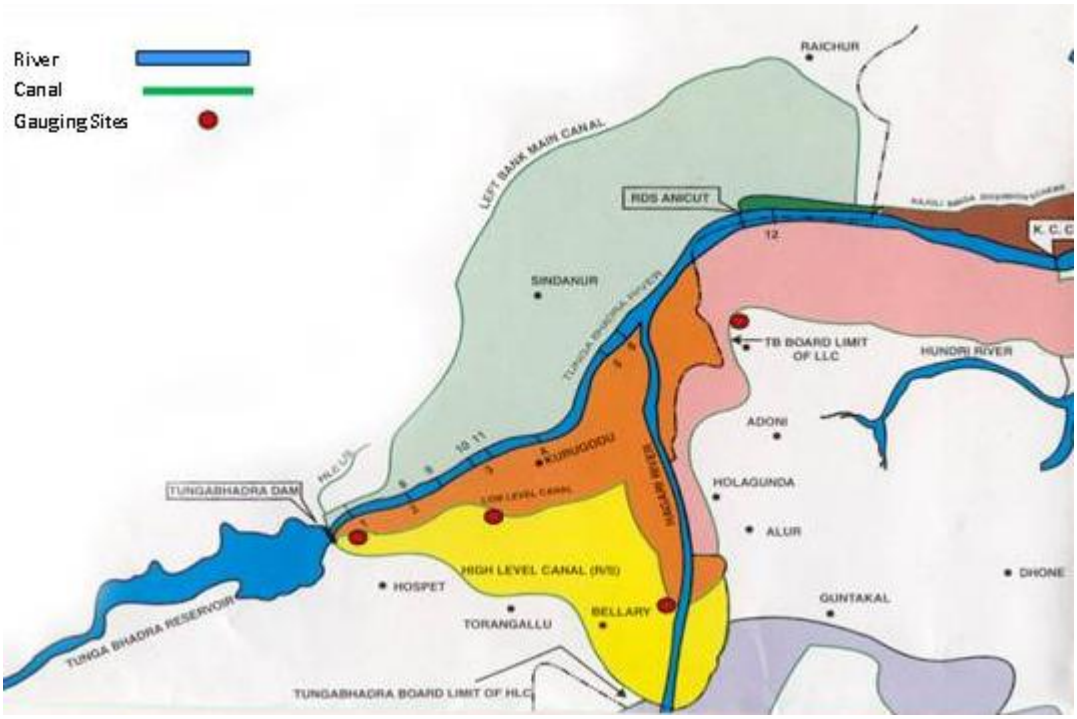


Dongargaon –Thanegaon LIS surge analysis
Air valves (9 nos.) and air vessel (75 m^3 capacity at chainage 60 m)

5181-FIELD STUDIES FOR RATING OF TUNGABHADRA RIGHT BANK POWER CANAL AT KM 0.750, LOW LEVEL CANAL (LLC) AT KM 2.842, LLC AT KM 118.700 & LLC BORDER AT KM 251.850, TUNGABHADRA DAM PROJECT, BELLARY, KARNATAKA

Tungabhadra Dam is constructed across Tungabhadra River near Hospet in Bellary district of Karnataka state. It is a multi-purpose and interstate project between Karnataka and Andhra Pradesh. High Level Canal (HLC), Power canal and Low Level Canal (LLC) from the right bank canal system take-off from Tungabhadra dam. The water from Tungabhadra dam, released into right bank canal is utilised for providing irrigation to agricultural lands in above states and for power generation. The Tungbhadra Board Authority requested Central Water and Power Research Station, Pune to undertake field studies for rating of Power canal at km 0.750, Low Level Canal (LLC) at km 2.842, LLC at km 118.700 & LLC border at km 251.850. The field studies were undertaken at above sites. The field measurements for gauge and discharge for above sites were carried out for different discharges under the stable flow conditions in the canal. The discharge in the canal was measured using Area Velocity method. The depth measurements were taken by Echo sounder and the velocity observations were carried out by using self recording propeller type currentmeter manufactured by Valeport Ltd. U.K. Based on statistical analysis of the data collected during the above field studies. Rating curves and rating tables based on this relationship have been evolved and recommended for estimation of canal discharge at these sites within the observed range .The Gauge-Discharge relationships, evolved from the statistical analysis of observed data are as under:

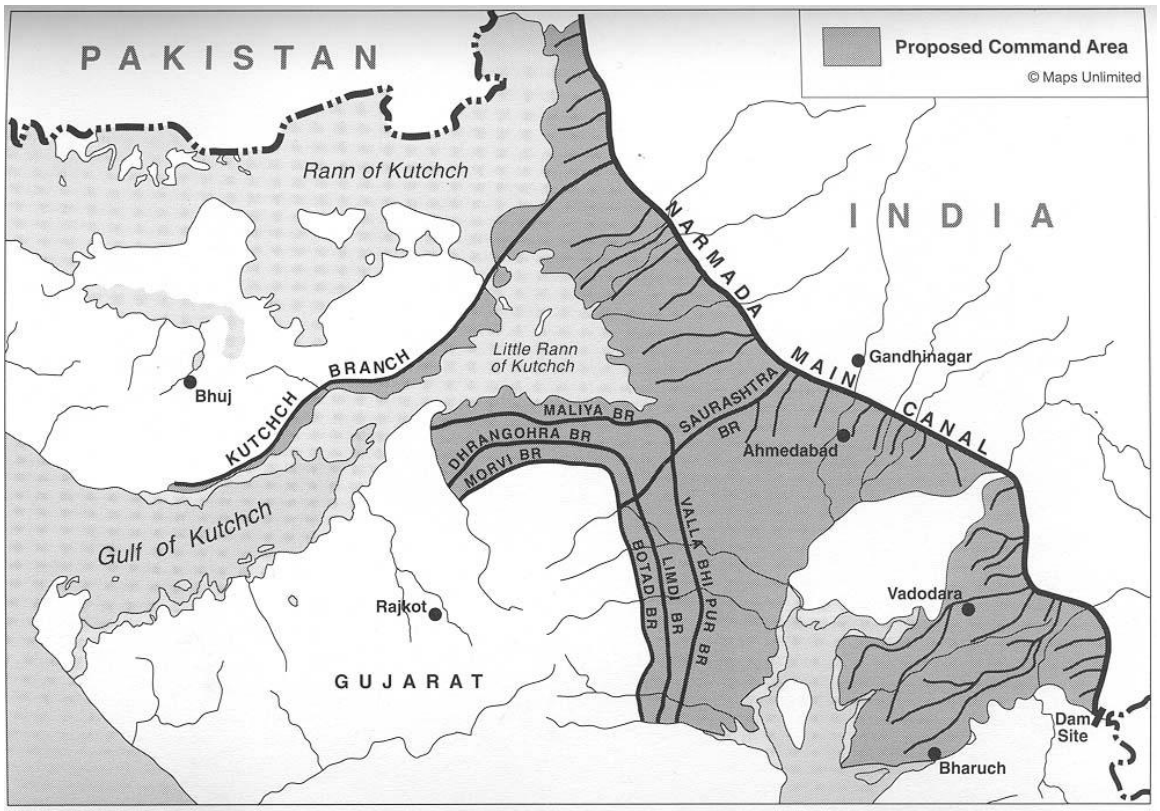
Tungabhadra Right Bank Power Canal at km 0.750 .....$Q = 4.4694\ G^{2.1769}$
Tungabhadra Right Bank Low leval Canal at km 2.842.....$Q = 13.44\ G^{1.274}$
Tungabhadra Right Bank Low level Canal at km 118.700.....$Q = 1.586\ G^{1.4316}$
Tungabhadra Right Bank Low level Canal (Border) at km 251.850...$Q = 7.7942\ G^{1.235}$
Where Q = Discharge in m^3/sec. and G = Gauge / depth in metre.



Location of gauging sites on tungabhadra canal

5282 - MATHEMATICAL MODEL STUDIES FOR ASSESSING THE EFFECT OF ADDITIONAL STRUCTURES ON LIMBDI BRANCH CANAL,SARDARSAROVAR NARMADA NIGAM LIMITED, GUJARAT

Limbdi Branch Canal (LBC) is 118.76 km long and takes off from Suarashtra Branch Canal (SBC) at chainage 89.14 km, with head discharge of 73.88 m^3/s and culturable command area (CCA) of 108, 343 Ha. SBC takes off from Narmada Main Canal, which is one of the largest canals in the world, with head discharge of 1,124m^3/s (40,000 cusecs). Studies were conducted to assess the effect of head losses due to the introduction of six additional structures on the existing LBC and their effect on water profile. A mathematical model was developed with existing structures of LBC and their water surface profile was compared with the design values provided by SSNNL. The discharge in the LBC has the maximum value of 73.88 m^3/s at the head of the canal, which keeps on reducing towards downstream as 19 distributaries cause withdrawal of flow from the main canal respectively. Various geometric and hydraulic features of LBC, which included canal syphon, cross-regulators, railway bridges/road bridges, distributaries off-taking from LBC have been incorporated as part of canal system in the development of mathematical model. Water surface profiles of the LBC, with and without introduction of six additional structures were compared. It was found that the presence of additional structures has caused the energy losses (or head loss) at the locations of additional structures. The water at upstream of these six additional structures have also gone up depending upon the distance and location from these structures. The maximum rise in water level of around 0.5 m has taken place at the chainage 73.80 km, which happens to be most upstream located additional structure and the back water effect broadly extends upto chainage 45.0 km. It is imperative that the top bank level of the canal in the region where the additional structures has caused the rise in water levels, is raised in accordance with rise in water level at the particular location and safety of other strutures.



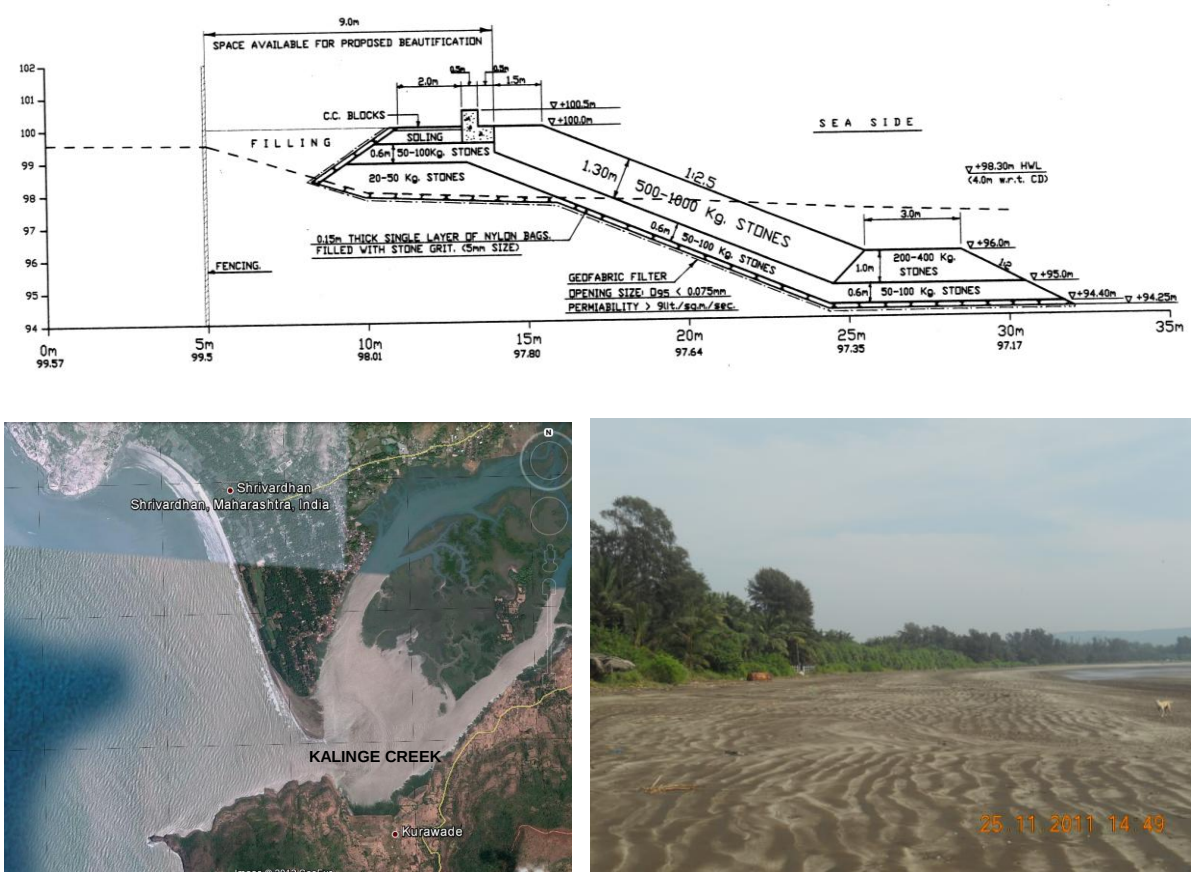
Limbdi branch canal in Narmada canal system

COASTAL AND OFFSHORE ENGINEERING

5171-DESIGN OF COASTAL PROTECTION WORK AT SHRIVARDHAN, DIST, RAIGAD

Shrivardhan is the famous tourist destination in Konkan and about 200 km south from Mumbai. The beach is always engaged during the entire year for the recreational activities by the tourists. In order to encourage tourists activities Government of Maharashtra have a proposal to develop various facilities for the tourists along with the beautification of the beach at Shrivardhan. In order to protect the proposed beautification scheme from the sea wave attack, there is a proposal to construct shore protection works at the Shrivardhan beach. The total length of the protection work is about 1200 m.

The studies have been conducted for evolving the design of the coastal protection work. As per the project requirement and the existing conditions at the site, the cross-section of the coastal protection work is evolved with stones through the desk studies. A rubblemound seawall consisting 500 kg to 1000 kg stones with 1:2.5 slope in the armour layer is proposed to sustain the breaking wave height of the order of 2.0 m. A 3.0 m wide crest with L-shaped PCC parapet wall is provided at top of seawall. A layer of PCC blocks resting on soling layer is recommended as a wearing coat at the crest.



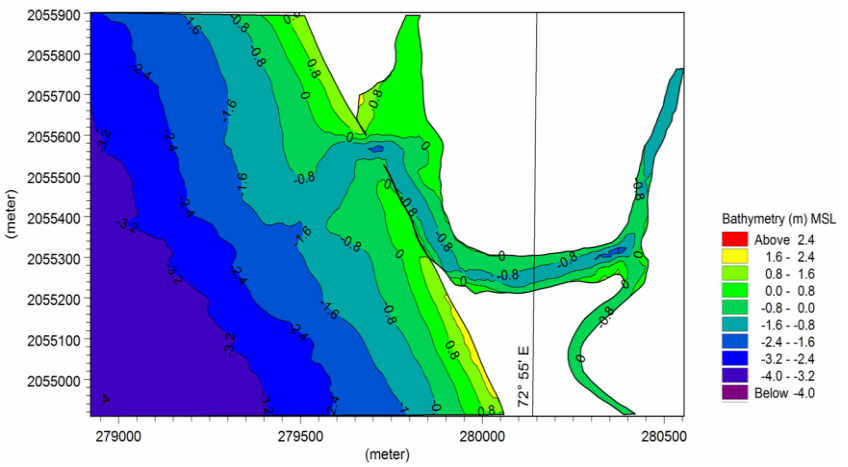
Site location & design of seawall at Shrivardhan, Raigad

5173-MATHEMATICAL MODEL STUDIES FOR TIDAL HYDRODYNAMICS AND SILTATION FOR THE PROPOSED DEVELOPMENT OF TRAINING WALL/GROYNES IN THE MOUTH OF THERONDA CREEK, RAIGAD DIST, MAHARASHTRA

Theronda is a small village situated at Latitude 18^0 34′ N and Longitude 72^0 55′ E, at about 15 km south of Alibag on the west coast of Maharashtra. The Maharashtra Maritime Board (MMB), a state government organisation, proposed to develop a fishing harbour in Theronda creek. Presently, the fishing harbour is lacking facilities for fish landing, berthing/parking of boats. Moreover, heavy deposition of sediments is experienced in the mouth of creek during non-monsoon period, thereby decreasing the waterway to a great extent. Due to this the navigation is possible only during high tide there by affecting the fishing activities and hence, it is proposed to develop new Fish Landing Facilities (FLC) under NABARD Scheme and to assure navigation through the mouth of the creek for the fishing boats in all phases of tide by channelizing the flow into the creek with the help of groynes.

2-D mathematical model studies were conducted for tidal hydrodynamics and sedimentation for different stages of development with the proposed channel of up to -2 m depth (CD) and two parallel groynes. For the purpose, MIKE21 HD module has been used to study the hydrodynamics and MT module to assess the net sedimentation in the channel, for assessing maintenance dredging per year.

The model was calibrated for the existing condition in order to reproduce hydrodynamic and siltation scenarios. The results reveal that provision of the groynes of length 360 m, channelized the flow and improved the flow conditions upon dredging the channel up to 0 m with tidal ranges of 4 m during spring period. The navigation is possible even during low water conditions. The increase in the dredging depth from 0 m to -2 m with 360 m and 850 m lengths of groynes decreased the siltation at the creek entrance and increased at the groyne entrance. The maintenance dredging at different locations for different phases of development i.e dredging up to 0 m and up to -2 m in the entire channel is worked out to be of the order of 22400 m^3 and 25800 m^3 respectively. The total siltation in different locations of the Theronda creek is worked out to be of the order of 43600 m^3 under stage-II development. Thus the 360 m long groynes would help to improve the conditions at Theronda Creek, if the channel depth is restricted to zero metre.



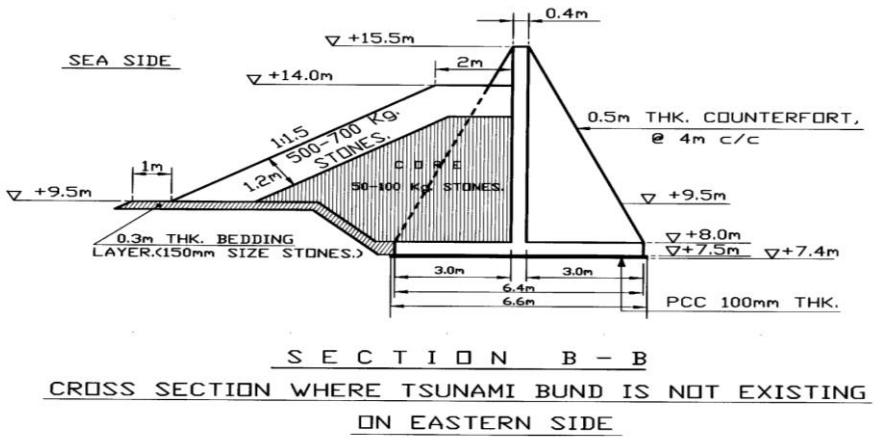
Bathymetry of Theronda creek

5176-DESK STUDIES FOR THE DESIGN OF COASTAL PROTECTION WORKS FOR PFBR PLANT SITE AT KALPAKKAM, TAMIL NADU

The Department of Atomic Energy (DAE) has two major establishments viz. Indira Gandhi Centre for Atomic Research (IGCAR) and Madras Atomic Power Station (MAPS) on the east coast of India at Kalpakkam, Tamil Nadu (Latitude 12^0 34′ N and Longitude 80^0 10′ E) at about 70 km south of Chennai. The DAE has also established a 500 MW power plant called, Fast Breeder Reactor Project (PFBR) at the Kalpakkam coast, near MAPS. Similar to the MAPS, the cooling water required for the PFBR is to be taken from the sea and the hot water discharge is to be let out in the sea through outfall channel. Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI) have referred the desk studies for the design of coastal protection works to protect the PFBR plant site from external flooding at Kalpakkam, Tamil Nadu to Central Water and Power Research Station (CWPRS), Pune.

It is proposed to construct walls / bunds on all sides of the project site except on the Western side since it is more than 500 m away from the shore and it is presumed that no water will enter the site from west side. The shore protection works on the seaward side of the outfall channel have already been implemented by the Project Authorities. However, for the design of the Protection Bund to protect the site from the external flooding like tsunami surge, it is required to consider the probable tsunami surge height. This tsunami surge height has been evolved as 6.90 m above the MSL i.e. +6.096+6.90 = 12.996 m. In view of this, it was decided by BHAVINI to keep the tsunami protection bund top as +15.5 m.

The existing tsunami bund of 200 m length in front of Nuclear Island is also taken into account as suggested, while designing the section in this stretch. The top level of the protection work (i.e. concrete wall) has been kept at RL +15.5 m. The section for 550 m long seaward face consists of a vertical concrete wall and a rubble protection with 500 - 700 kg trap stones (in double layer) in the armour layer with a slope of 1:1.5 on seaside. On the northern and southern stretches of the plant, a rigid concrete protection wall has been suggested. As the ground level is rising as we move towards land, the height of the retaining wall will also reduce, keeping its top level at RL +15.5 m.



Tsunami protection bund with retaining wall for 500 MW PFBR project, Kalpakkam

5181-DESK STUDIES TO ASSESS THE EFFECT OF DEVELOPMENT OF COAL BERTH 3 AND 4 ON THE SHORELINE AT KAMARAJAR PORT, ENNORE, TAMIL NADU

M/s Kamarajar Port Ltd. (KPL), Ennore, Tamil Nadu state is planning to develop Coal Berths 3 & 4 to meet the additional demand for the coal traffic. In this context M/S Asian Consulting Engineers (ACE) Pvt. Ltd, New Delhi, has been appointed as the Environmental consultants by the KPL authorities. The desk studies to assess the shore line changes due to the development of these berths were referred to CWPRS by M/S ACE and the studies were carried out utilizing available data. The Coal Berths 3 & 4 are proposed to be developed by creating a dock basin within the existing port basin. The proposed development involves about 2.6MCM of capital dredging. The type of dredged material was assessed by using the borehole data of the development area. The dredged material mainly comprises of dense grey silty fine sand, grayish silty sand, grey sandy silt, very stiff grey silty clay with traces of fine sand, dense silty fine sand and top soil with vegetative cover.

Since the development area is within the harbour basin there will be no adverse effects on the shoreline adjacent to the port by this development. It is however suggested to dispose the dredged material according to the suitability considering the properties of the soil dredged and use the top vegetative fertile soil for the existing plants and trees in the port area effectively. Suggestions were also made to replant the plants disturbed during the development of coal berths. It was suggested not to dispose the scrap from dismantled structures in the offshore or north coastline. The strategies for the disposal of the dredged material for land reclamation, beach nourishment and deep sea disposal are also suggested in the report. A brief review of various earlier studies conducted on the shoreline management and beach nourishment for the KPL by CWPRS is also made in the report.

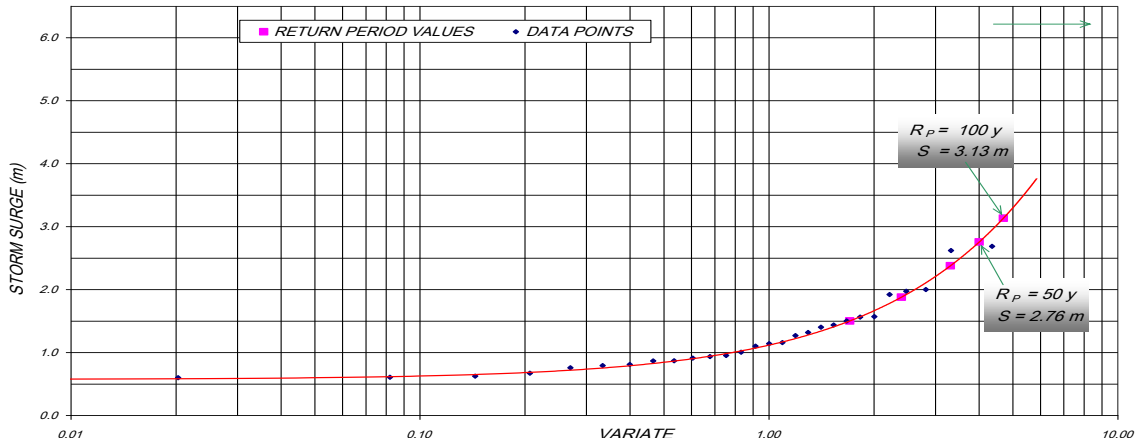
Satellite image showing area of proposed Coal Berth - 3 & 4

5184-STORM SURGE ANALYSIS FOR THE PROPOSED THERMAL POWER PLANT OF RIL AT HAZIRA, GUJARAT

Reliance Industries Limited (RIL) intends to develop a 360 MW coal fired power plant at Hazira. Location of Proposed Power Plant is in a Triangular Plot adjacent to the RIL Petrochemical complex at Hazira . The plot area is approximately 269 acres. The triangular plot is located abutting to Tapi river. Studies for storm surge analysis were carried out for designing the safe grade elevation for Thermal Power Plant at Hazira considering the past storm data of 44 cyclones, which are significant for Hazira coast, occurred during the period of 40 years from 1969 to 2009.

The storm surge analysis was carried out using an empirical method developed by Sylvester, from the cyclonic parameters like pressure drop, wind speed, location and duration of the storm and fetch length. The hindcast data of the surge heights were subjected to extreme value analysis using Gumbel (Type-I), Weibull and Log–Normal distributions to determine the storm surge values for different return periods.

The extreme value analysis of the hindcast storm data indicated a storm surge value of 3.17 m, and 2.78 m for 100-years, and 50-year return period respectively for the Hazira coast. These values would be useful for designing the safe grade elevation of Thermal Power Plants at Hazira.



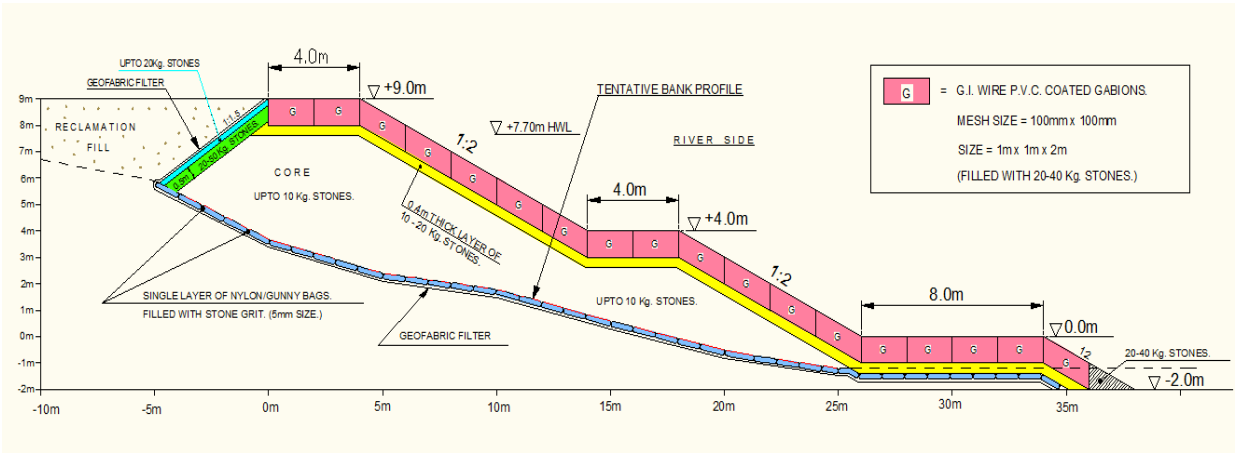
Hindcast storm surge data of Hazira coast on Gumbel distribution

5185-BANK PROTECTION WORKS FOR THE PROPOSED POWER PLANT OF M/S RELIANCE INDUSTRIES LTD. AT HAZIRA, GUJARAT FOR M/S WAPCOS

The Reliance Industries Limited (RIL) is proposing to generate 380 MW power by building and operating thermal power at their Triangular plot at Hazira, Gujarat. The Triangular plot proposed for development is situated on the right bank of the Tapi River. National Thermal Power Corporation (NTPC) Complex is situated on its northwest, KRlshi Bharati Company (KRIBHCO) on east and to its northwest is Reliance Industries Limited (RIL) complex and further southwest is Laursen and Tubro (L&T).

The main objective of the studies is to prevent landward erosion of the northern river bank for extreme conditions of tide and discharge from Ukai dam. Studies were carried out for the hydraulic design of the cross-sections for the protection bund. The section consists of PVC coated G.I. wire gabions of 1 m x 1 m x 2 m size filled with 20-40 kg stones on 1:2 slope. A 4 m wide berm is provided in the armour at +4.0 m level to enhance the stability of the bank protection works. The crest of the protective work is kept as +9.0 m and the toe berm level is at +0.0 m . The toe berm consists of gabion 1 m x 1 m x 2 m laid horizontally to serve as an apron. A 4.0 m wide crest is provided with the same gabion. The core consists of stones upto 10 kg weight. A layer of geo-fabric filter is provided at the base of the bund in order to avoid the leaching of the sand. A single layer of (0.15 m thick) jute/nylon bags filled with stone grit (size 5mm appx) is provided over the geo-fabric filter to act as a cushion between the stones and geo-fabric filter. A geo-fabric filter is also provided on the leeside to avoid leaching of sand through the voids after reclamation fill.

Triangular Plot at bank of Tapi River, Hazira , Gujarat

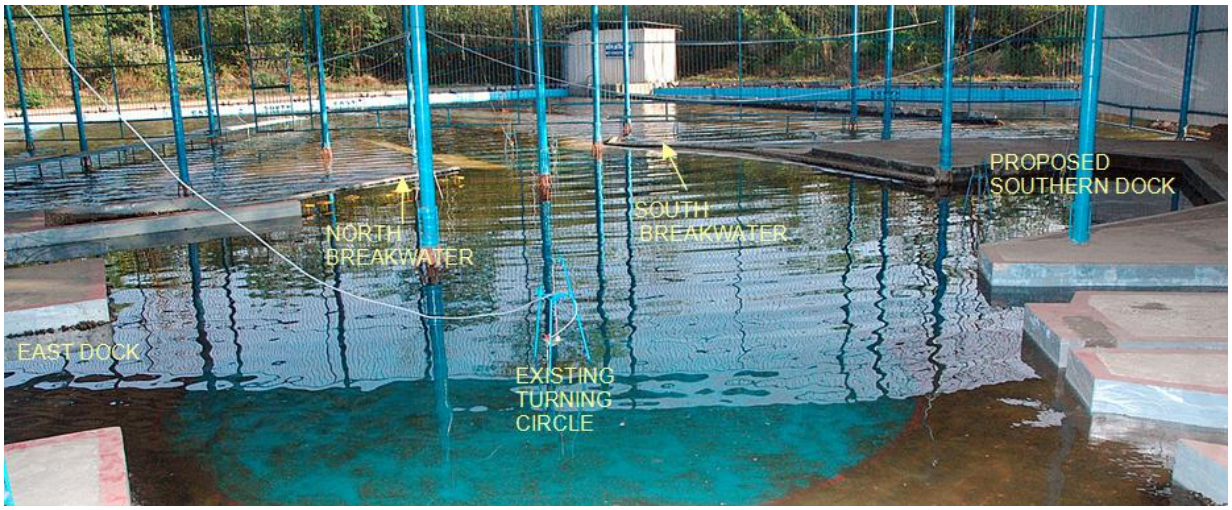


Bank protection work for triangular plot at Hazira

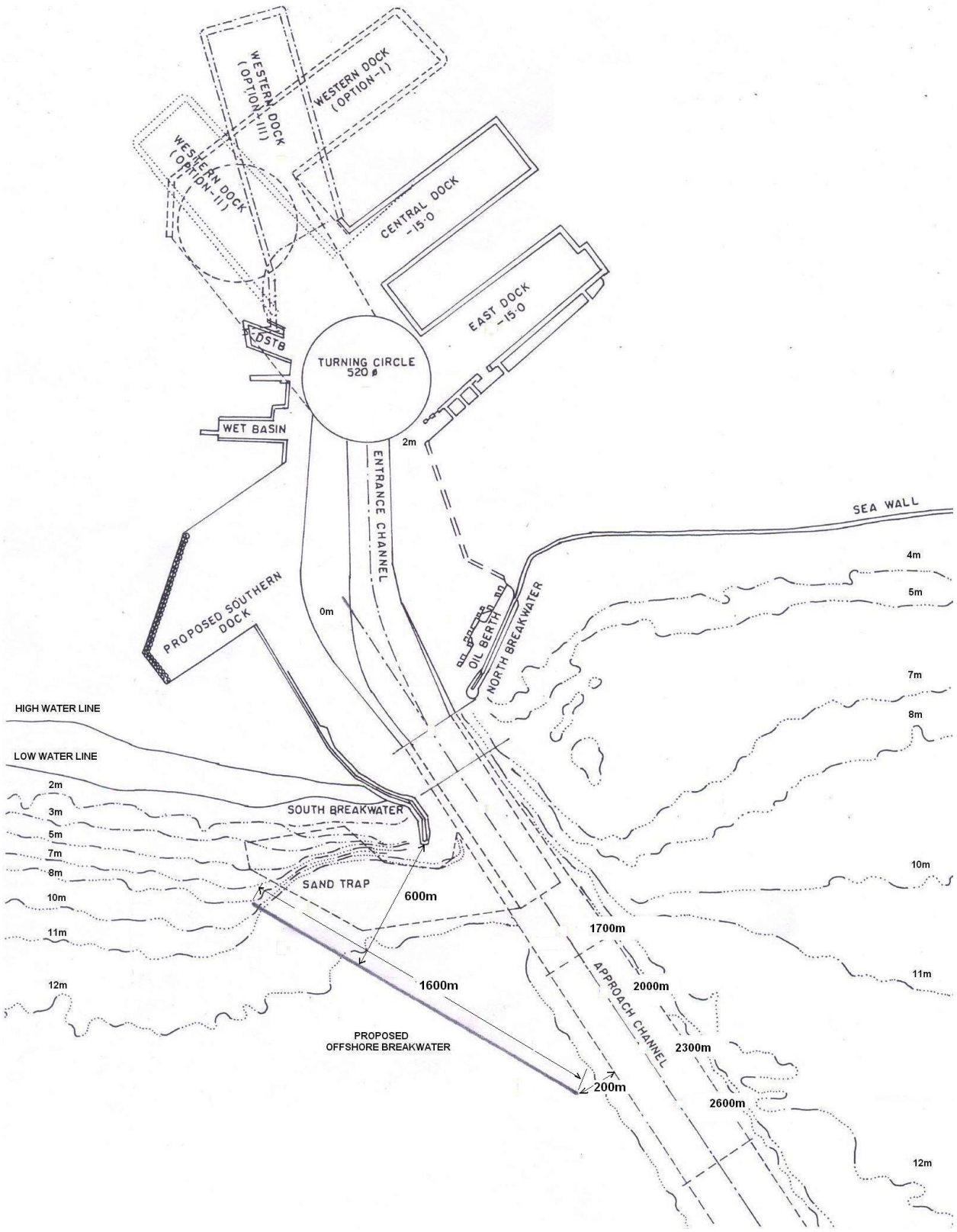
5188-PHYSICAL MODEL STUDIES FOR THE LAYOUT OF THE PROPOSED OFFSHORE BREAKWATER AT PARADIP PORT, ODISHA

Paradip Port, which is one of the major ports of India, is situated on the east coast of Odisha. Presently the Port handles vessels up to 1, 25,000 DWT for different types of cargo. The port proposes to expand its handling capacity for the traffic volume of next twenty years by developing a new dock, southern dock and western dock. The port is initially deepened its entrance channel to -17.1m and approach channel to -18.7m to cater 1,25,000 DWT vessels. The Port also proposes to construct an offshore breakwater to provide tranquil conditions at the sand trap to facilitate the dredgers to dredge the sand trap at all the time and also to provide sufficient stopping distance for the bigger ships Studies were carried out for the offshore breakwater using numerical models during the year 2006 and based on extensive studies, an offshore breakwater with a length of 1600m was suggested.

3-D wave model studies were also carried out to confirm the length and layout of the offshore breakwater. Two different lengths of 1300m and 1600 were studied in the existing physical model with a scale of 1:125 (GS) having facility to reproduce waves from the two predominant wave directions of East-South-East and South, which represents waves during North-East and South-West monsoons respectively. The studies revealed that, both the alternatives were found suitable for harbour area and navigational channel. However, for getting tranquil conditions in the sand trap area, a proposal with 1600m length with layout shown in Fig.-1 is more suitable. The wave disturbances on leeside of the offshore breakwater were tranquil and suits to berth tankers of more than 1, 25,000 DWT. Hence, it is recommended that, the area of leeside of the offshore breakwater can be utilized for future expansion of the port facility.



1 Waves simulated from east-south-east direction in the physical model of Paradip port

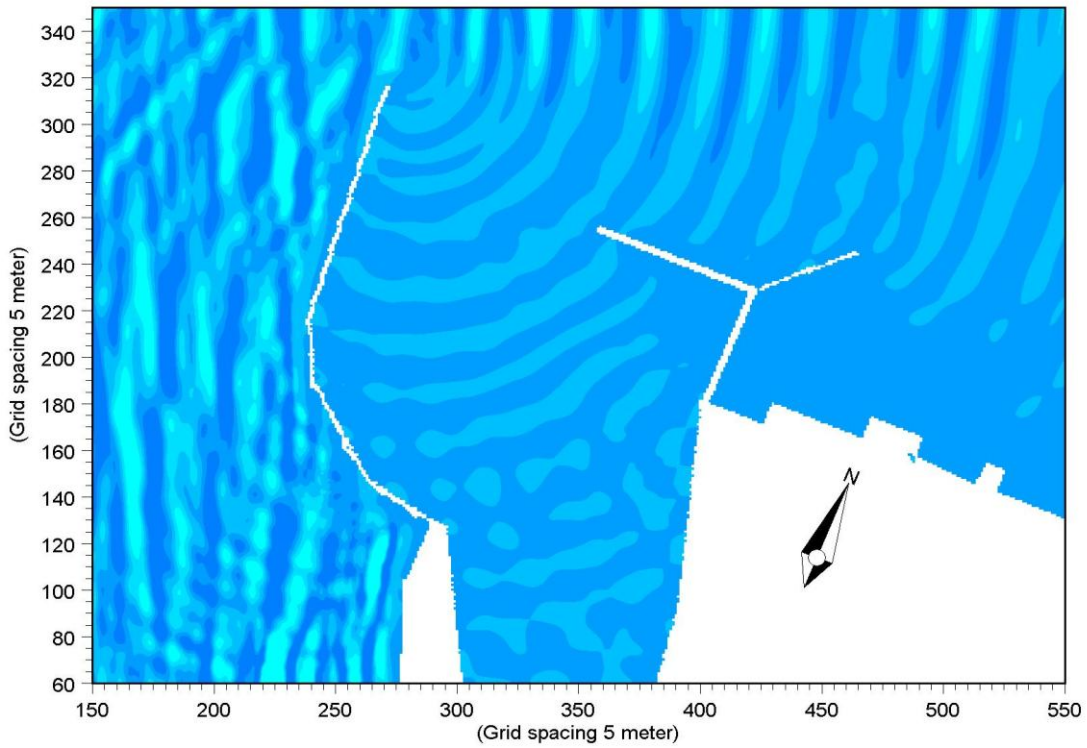


Layout of the proposed 1600m offshore breakwater at Paradip port

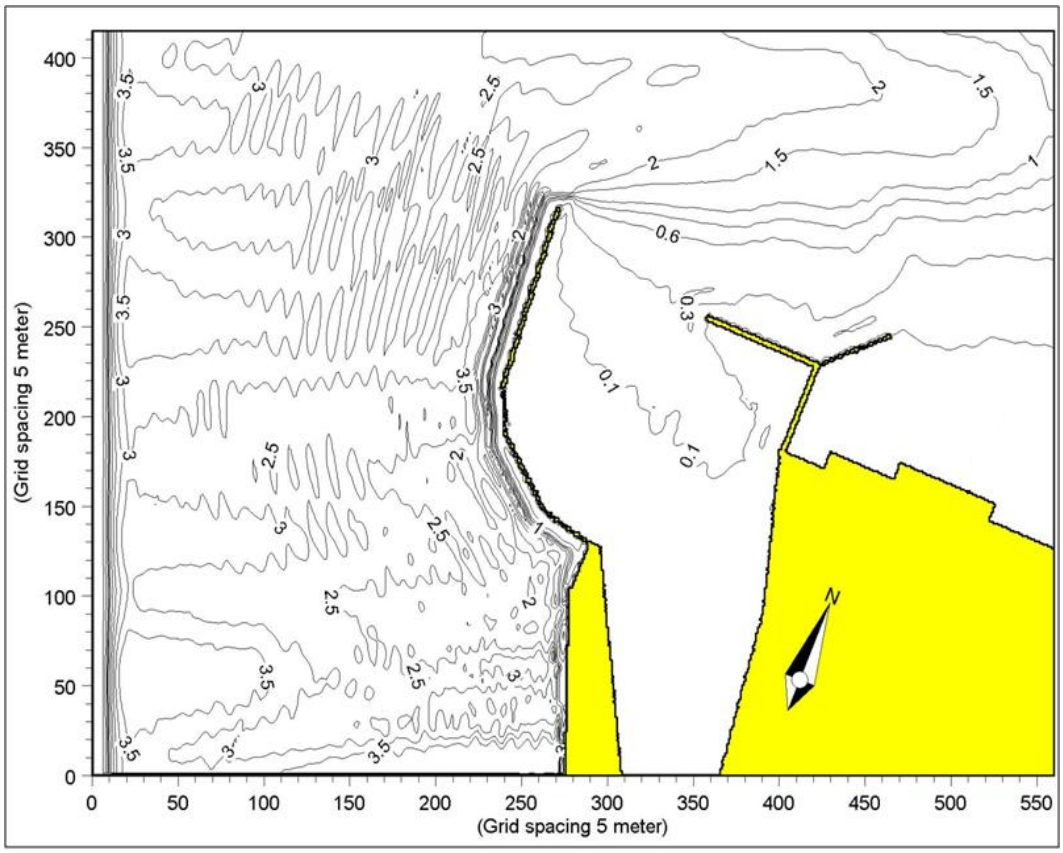
5190-MATHEMATICAL MODEL STUDIES FOR WAVE TRANQUILITY IN THE AREA OF PROPOSED RO-RO JETTY AT JAITAPUR, MAHARASHTRA

Jaitapur is situated in Rajapur Taluka of Ratnagiri District in Maharashtra, the west coast of India about 50 km south of Ratnagiri. There is a proposal of Nuclear Power Corporation of India Limited (NPCIL), Mumbai to establish Nuclear Power Plant (NPP) of total installed capacity of about 10000 MWe at Jaitapur. The cooling water required for the power plants is proposed to be withdrawn from sea and the warm water would be discharged back to the sea at a suitable location. There will be six units with cooling water requirement of each unit is 110 cumecs. There is a proposal of a RO-RO jetty to facilitate transport of raw material required for the NPP. The Proposed Layout includes an intake channel and three breakwaters.

Mathematical model studies for wave tranquility in the area of proposed RO-RO jetty were carried out to examine wave tranquility for the proposed layout and to arrive at a suitable port layout. The studies were carried out in two phases i.e., initially to carry out the wave transformation from offshore to near shore region to get the wave conditions at the proposed site by using OUTRAY model. Subsequently wave tranquility studies were conducted by using MIKE 21 BW model to predict the wave disturbance in and around the proposed developments. The model studies using the OUTRAY model indicated that the predominant wave directions of wave approach in 12 m depth at Jaitapur are from West , WSW and SW direction with percentage of occurrence about 51%, 33% and 13% respectively. The model studies indicated that with the proposed layout, the berths and jetties in the lee side of south breakwater can be safely operated for about 300 days in a year. Further studies were conducted to optimize the port layout by removing the eastern breakwater. The model studies also indicated that there is no significant difference in the wave tranquility with and without the eastern breakwater.



Surface elevation plot for layout II with incident wave height =3.5m and direction =WSW

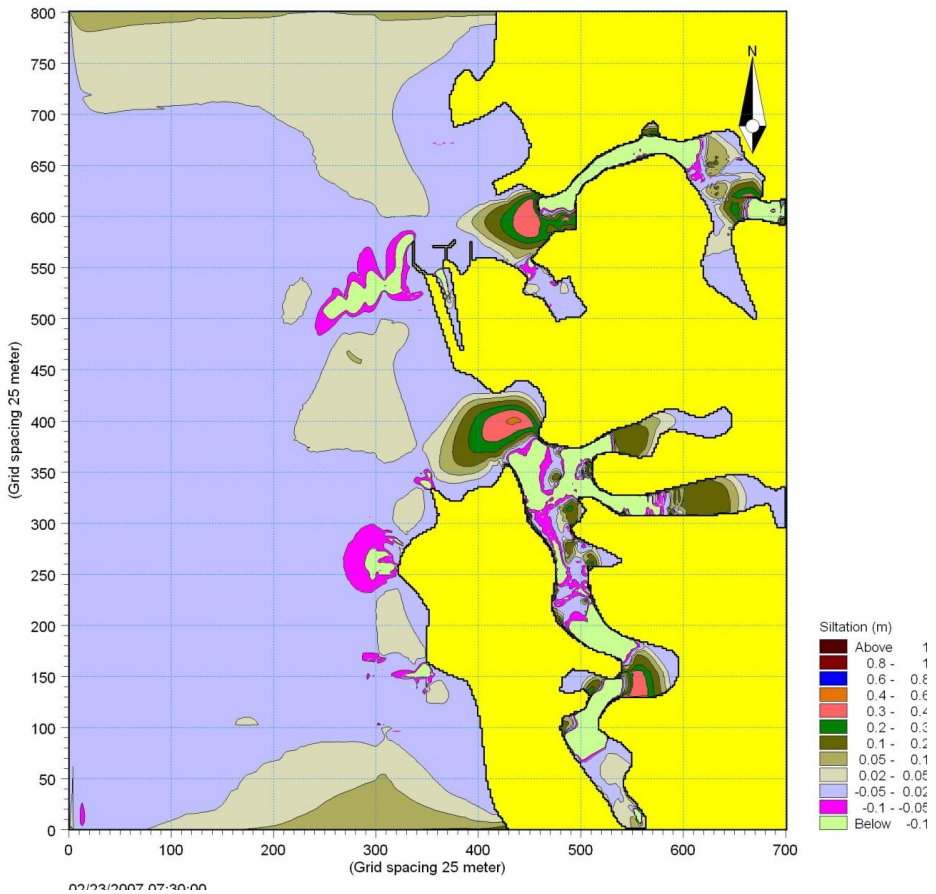


Wave height distribution for layout II
for wave height=3.5 m, direction=WSW

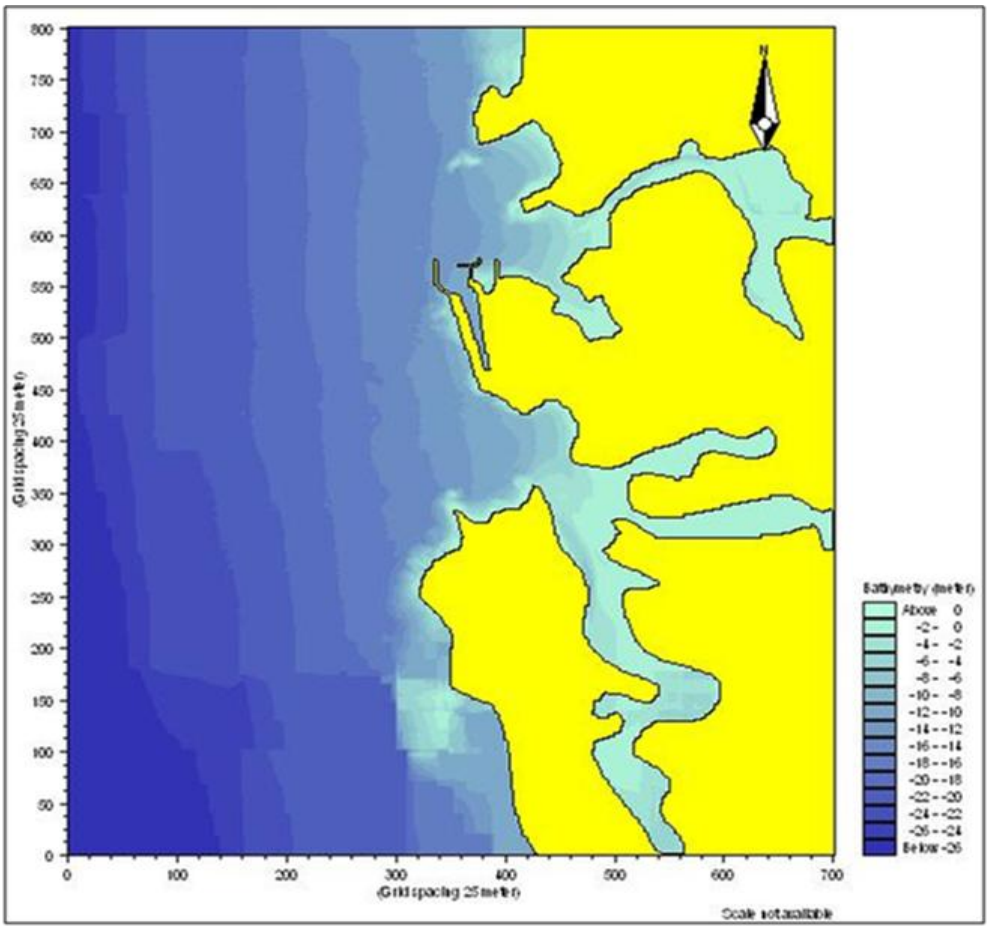
5191-MATHEMATICAL MODEL STUDIES FOR TIDAL HYDRODYNAMICS AND SEDIMENTATION DUE TO THE PROPOSED RO-RO JETTY AT JAITAPUR, FOR NPCIL, MUMBAI, MAHARASHTRA

Jaitapur is situated in Rajapur Taluka of Ratnagiri District in Maharashtra, on the west coast of India about 50 km south of Ratnagiri. There is a proposal of Nuclear Power Corporation of India Limited (NPCIL), Mumbai to establish Nuclear Power Plant (NPP) of total installed capacity of about 6x1650 MWe at Jaitapur. The cooling water required for the power plant is proposed to be withdrawn from sea and the warm water would be discharged back to the sea at a suitable location. To facilitate power plant operations a RO-RO jetty is also proposed with suitable breakwater for the protection.

The mathematical model studies for tidal hydrodynamics and siltation aspects for the proposed NPP at Jaitapur were carried out at CWPRS by two dimensional vertically averaged mathematical models MIKE21 HD and MT for a given layout of Harbour and Intakes/Outfalls with the existing natural coast at the proposed harbour location and with the proposed layout. The proposed layout was tested for changes in flow field and siltation pattern. From the studies it was concluded that the flow field is generally smooth and conducive with Proposed Layout of the breakwaters without significant circulations. The siltation studies were conducted with the sediment data available with CWPRS around the proposed project site. The sedimentation study indicated that with the Proposed Layout, it is observed that the there is no significant change in the trend of deposition pattern, but at the tip of the outer breakwater there is a slight tendency of erosion in the outer sea which may be a temporal phenomenon and may not have much impact on the harbour operations, thus it could be seen that the flow field is generally weak and smooth without significant circulations and thus conducive with the modified layout of the breakwaters without eastern breakwater. The hydrodynamic and siltation studies also predict that the modified layout is suitable for operations of RO-RO Jetty.



Sedimentation pattern with proposed port layout

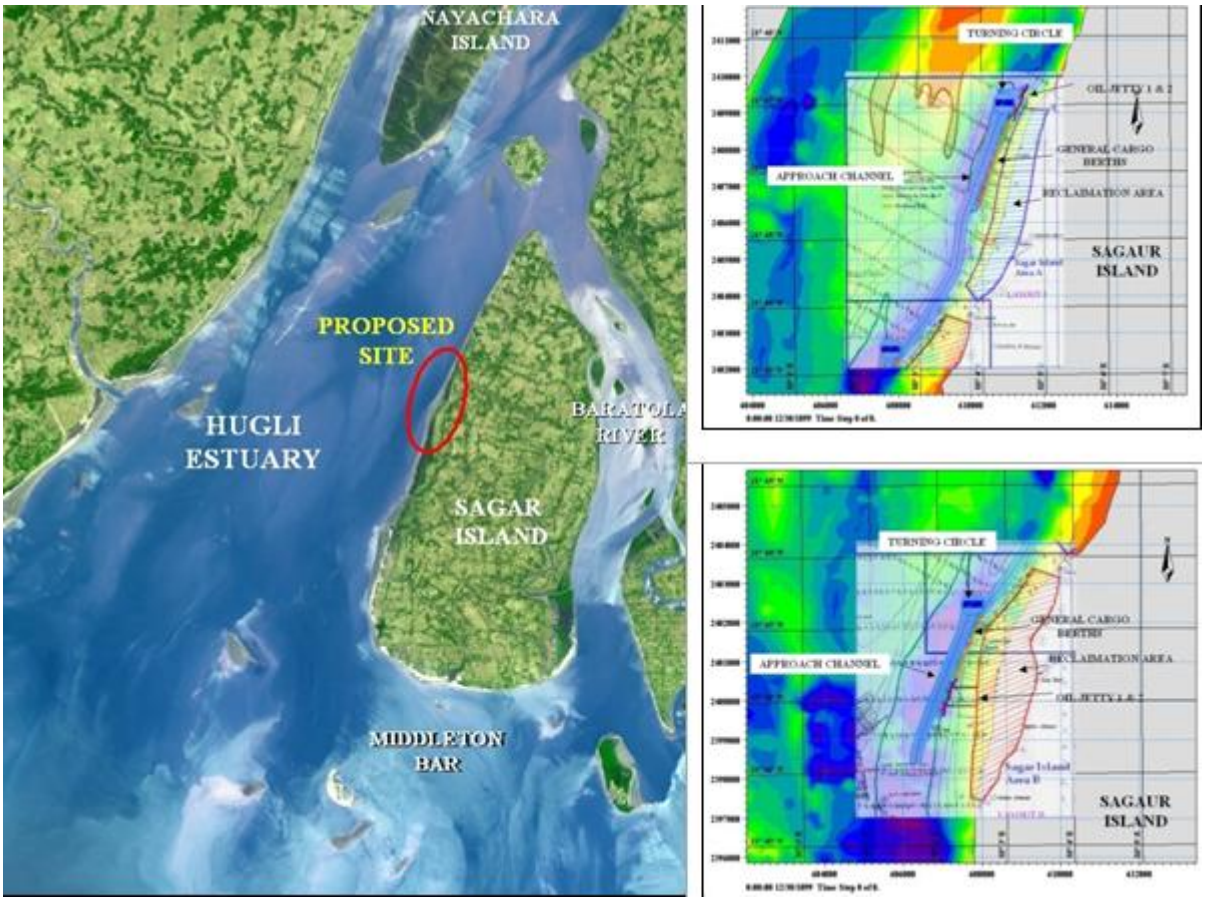


Computational model showing bathymetry with proposed development

5194-MATHEMATICAL MODEL STUDIES FOR HYDRODYNAMIC AND SEDIMENT TRANSPORT FOR PROPOSED PORT FACILITIES AT SAGAR ISLAND IN HUGLI ESTUARY, WEST BENGAL

The Kolkata Port trust (KoPT) in West Bengal is facing problem of critical draft due to massive siltation in the area and hence planning for new berthing facilities with more stable navigation route. The mathematical model studies were carries out at CWPRS for the assessment of hydrodynamic and morphological feasibilities for constructions of new berthing facilities on the west bank of Sagar Island in Hugli Estuary. The mathematical models were setup with necessary calibration and validation using the prototype data supplied by the KoPT. Hydrodynamic model studies to examine the flow conditions and to decide the optimum location / alignment for multiple jetties were conducted. Studies also included feasibility of two reclamations required for berthing facilities, turning circle and navigational channel along the western bank. Morphological model studies to assess the likely changes in bathymetry and estimation of probable siltation rates / maintenance dredging in the proposed berthing areas and in the channel were also conducted. The following conclusions were drawn based on the model studies:

- The deep natural bathymetry along the west bank of Sagar Island is suitable for developing berthing area for catering to 10.5 m draft vessels.
- The hydrodynamic simulations indicate dominance of flood currents south west of Sagar Island and ebb currents in the Eastern channel region.
- The seven berths will have to be aligned in three different configurations.
- The maintenance dredging in the dredged areas of the proposed turning circle, berthing basin and approach channel would be of the order of 4.5 to 5 Million cum per annum.



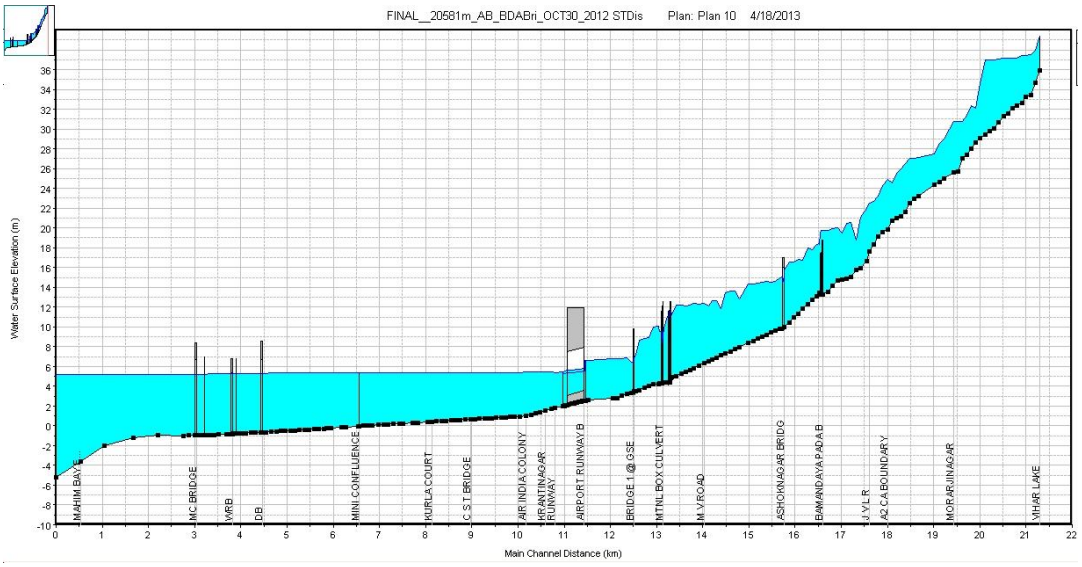
Site of proposed development on western bank of Sagar Island

5196-MATHEMATICAL MODEL AND DESK STUDIES FOR PROPOSED FLYOVER BRIDGE ACROSS MITHI RIVER JUST UPSTREAM OF MINI CONFLUENCE, MUMBAI

In the view of the fast growing and developing area of Bandra Kurla Complex in North Mumbai with special stress on International Business, Banking, Finance and other related activities. The fast growing development creates a very large employment in the vicinity area. At present traffic from Eastern suburbs, Thane and Navi Mumbai has to take a circuitous route via Sion and Dharavi to reach BKC. These experiences very heavy traffic congestion in surrounding area with lose of valuable time, energy, money of manpower and considerable delay. With this all background Mumbai Metropolitan Region Development Authority (MMRDA), Mumbai has planned and proposed a overhead Flyover Bridge crossing Mithi River just upstream of Mini Confluence, to link the area of 'G' Block and Mahim Nature park through Eastern Express Highway (EEH) as part of Mumbai Urban Town Planning (MUTP) Scheme to improve the traffic condition and accessibility to BKC.

After the unprecedented rainfall and floods in Mithi River, Mumbai on 26th July 2005 the Mithi River Development and Protection Authority (MRDPA) implemented the Mithi River channelization program recommended by Central Water and Power Research Station (CWPRS), Pune, through Municipal Corporation of Greater Mumbai (MCGM) and Mumbai Metropolitan Region Development Authority (MMRDA). A part of the Mumbai International Airport is constructed across the Mithi River by providing Box Culvert. The Mumbai International Airport Pvt. Ltd. (MIAL), Mumbai has proposals for improving the operational facilities in the area adjoining the Mithi river. MIAL has plans to construct two bridges viz. Road Bridge No.1 near Ground Service Equipment (GSE) area on Mithi River, upstream of MIAL area and another Additional Waterway Channel parallel to the existing Airport Runway Box Culvert for improving the conveyance in the Mithi river reach falling within the Airport area.

MIAL approached CWPRS to conduct the 1-D mathematical model studies for said bridge structures. CWPRS has undertaken the model studies using the public domain software HEC-RAS, developed by U.S. Army Crops of Engineers, USA. The bridge proposals were simulated in the model for rainfall event of 100 year return period having one-day maximum rainfall of 570 mm, obtained from analysis of latest Isopluvial Maps received from India Meteorological Department (IMD). The sea tide boundary at Bandra point in Mahim Bay specified as a stage hydrograph and peak ordinates of flood hydrographs computed using the Rational Method and CWC method were applied at upstream boundary. The model simulations were done for steady state discharge conditions due to steep river gradient in upstream reach causing super critical flow conditions. Model simulations indicated that the 100 year return flood water levels would be well within the deck levels of the box culverts and will not have adverse afflux conditions at the upstream and downstream of the bridge structures.



Longitudinal Profile of Maximum Flood water Levels in Mithi River

5198-MATHEMATICAL MODEL STUDIES FOR TIDAL HYDRODYNAMICS AND SILTATION ASPECTS FOR DEVELOPMENT OF FISHERIES HARBOUR AT MANJESHWAR, DISTRICT KASARGOD, KERALA

The Harbour Engineering Department (HED), Government of Kerala, has proposed construction of an open coast fisheries harbour at Manjeshwar. The river bay has been formed at the confluence of River Uppala joining from the south and the River Manjeshwar joining from the east. Both the rivers discharge into this bay, before joining the Arabian Sea through this gut. During low water (LW) the river bay gets completely exposed, and the river flows freely into the sea at about 50 m away from mid gut near a big boulder. Due to which fishermen face difficulties in entering the existing harbour in the river bay during LW. The present natural gut is located at (12°42'30.91"N, 74°53'14.19"E).

During jet probing of the river bay HED found that there are rocks at relatively low depths, making it difficult to develop harbour by dredging this area, so an outer harbour is planned. Three different harbour layouts were suggested by HED for investigation – one to the north side of the present gut, the other to the south side, and the third enclosing the gut, with the entrance facing southward in each case.

In the absence of near-shore current observations and off-shore bathymetry CMAP data were consistently adopted in setting up the model by taking appropriate hydrodynamic parameters to optimise flow field to that of observed current data at the existing gut.

Many alternate alignments for the port layout along with those tentatively proposed by HED, have been tested with a view of wave tranquility and shoreline changes. Based on results of optimal sedimentation studies, a modified port layout, with entrance facing west near the NW corner and having shore connected north breakwater of length 750 m and south breakwater of length 850 m was recommended. The report describes the results of optimal layout of breakwaters of harbour for tidal hydrodynamics and siltation, along with an additional proposal of straight breakwaters at the present gut and proposed dredging of the existing bay.

The results of studies, based on the data supplied by HED indicate an annual siltation of 0.028 Mm^3 for the proposed outer harbour layout but with the existing bathymetry. The capital dredging for -3.5 m depth inside the harbour would be of the order of 0.45 Mm^3. The annual siltation in the enclosed harbour would be about 7000 m^3.

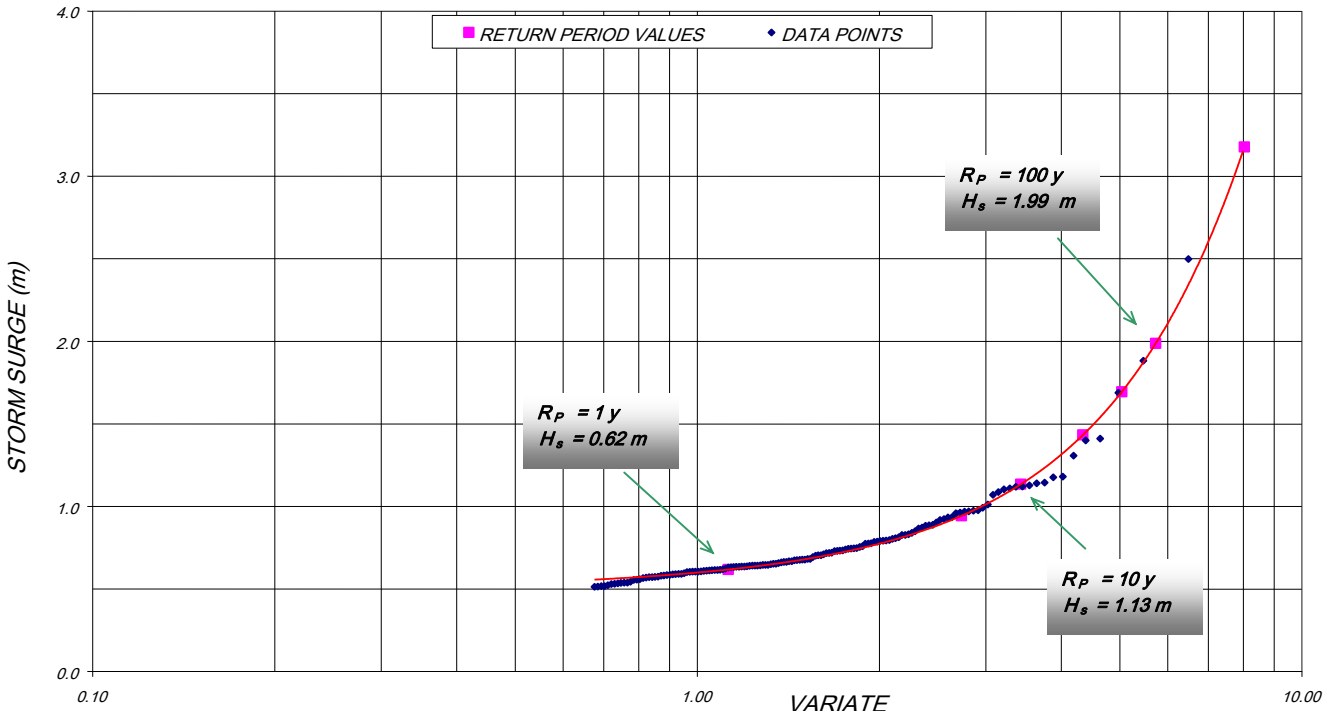
5200-STORM SURGE ANALYSIS FOR THE PROJECT VARSHA IN ANDHRA PRADESH

The Indian Navy have a proposal to develop a naval harbour on the east coast, about 80 km south of the existing Vishakhapatnam Port in Andhra Pradesh. The proposed site is located at the mouth of Sharada and Varaha Rivers near Bagarammapalem Village. The proposed naval harbor facility is called as "Project Varsha'. The main objective of the studies is to evaluate the storm surge values to determine the extreme water levels at Project Varsha

Studies for storm surge analysis were carried considering the past storm data of 370 cyclones, which are significant for the coast, occurred during the period of 120 years from 1891 to 2010.

The storm surge analysis was carried out using an empirical method developed by Sylvester, from the cyclonic parameters like pressure drop, wind speed, location and duration of the storm and fetch length. The hindcast data of the surge heights were subjected to extreme value analysis using Gumbel (Type-I), Weibull and Log–Normal distributions to determine the storm surge values for different return periods.

The extreme value analysis of the hindcast storm data indicated a storm surge value of 1.9 m, 1.2 m and 0.6 m for 100-years, 10-years and 1-year return period respectively for the Project Varsha coast. These values would be useful for to determine the extreme water levels at Project Varsha.



Hindcast storm data of project Varsha on Gumbel distribution

5206-MATHEMATICAL MODEL STUDIES TO EXAMINE THE DISPERSION OF EFFLUENT DISCHARGE AT THE OUTFALL LOCATED NEAR PROPOSED PORT OF M/S JSW AT NANDGAON, THANE, MAHARASTRA

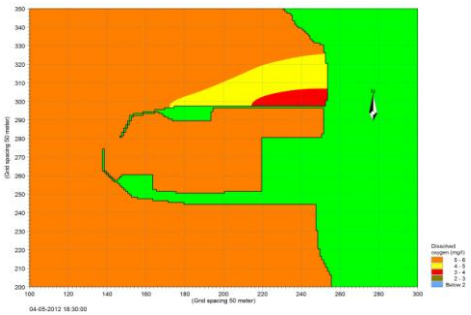
M/s JSW Infrastructure Limited (JSWIL), Mumbai proposes to develop all-weather captive port facilities at Nandgaon to serve the needs of JSW steel & power plants along with serving the need of the industries located in the Maharashtra Industrial Development Corporation (MIDC), Tapapore and Vapi industrial area as a Dedicated Freight Corridor. In the vicinity of the proposed port, there exists an outfall discharging wastewater (effluent) to the seashore from the industrial establishments of MIDC area. On discharge to the seashore, the wastewater is subject to dispersion in natural environment affecting the ambient characteristics of the region. In order to ascertain the impact of effluent dispersion in seawater in the proposed port area, mathematical model studies have been referred to CWPRS by Maharashtra Maritime Board (MMB), Mumbai.

Mathematical model studies for simulating dispersion of the various water quality parameters such as; BOD, DO, ammonia, nitrate, phosphate due to the industrial effluent discharged from the existing outfall were carried out using two dimensional modelling techniques in MIKE 21 under the prevailing tidal conditions. The region considered in the model covered about 20 km X 40 km in sea portion extending up to about -20.0 m contour including the existing outfall. The region was schematised with 400 X 800 grid points of grid size 50 m X 50 m. There were three open boundaries in sea portion of the model. At the northern and southern open boundaries, tidal variations were used as boundary conditions and at the western open boundary, no flow condition across the boundary was imposed. The hydrodynamics in the model region was simulated for existing condition and was calibrated against field observed current data. Calibrated Model was run with the effluent discharge from the existing outfall under the proposed condition of the port layout comprising two breakwaters and an approach channel. Hydrodynamic and water quality model studies were carried out for following scenarios:

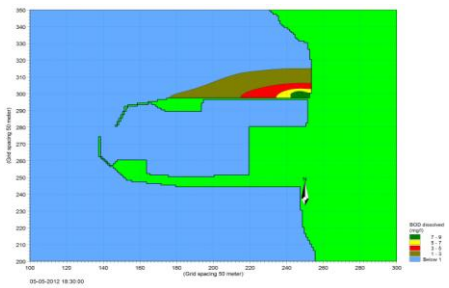
1. Simulation of Effluent Dispersion with Existing Outfall and without Proposed Port layout
2. Simulation of Effluent Dispersion with Existing Outfall and with Proposed Port layout having assumed discharge of 1000 BOD

Based on the results of the studies it is inferred that the water quality of the proposed port region and the nearby coastline will not be affected due to the discharge of industrial effluent from the existing outfall. It is unlikely that the dispersion plume will enter inside the port area. Hence, there will not be any impact in the proposed port region.

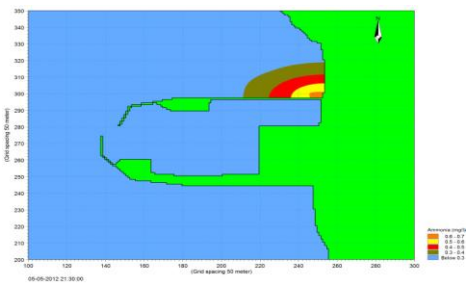
Location map



Distribution of DO with proposed port



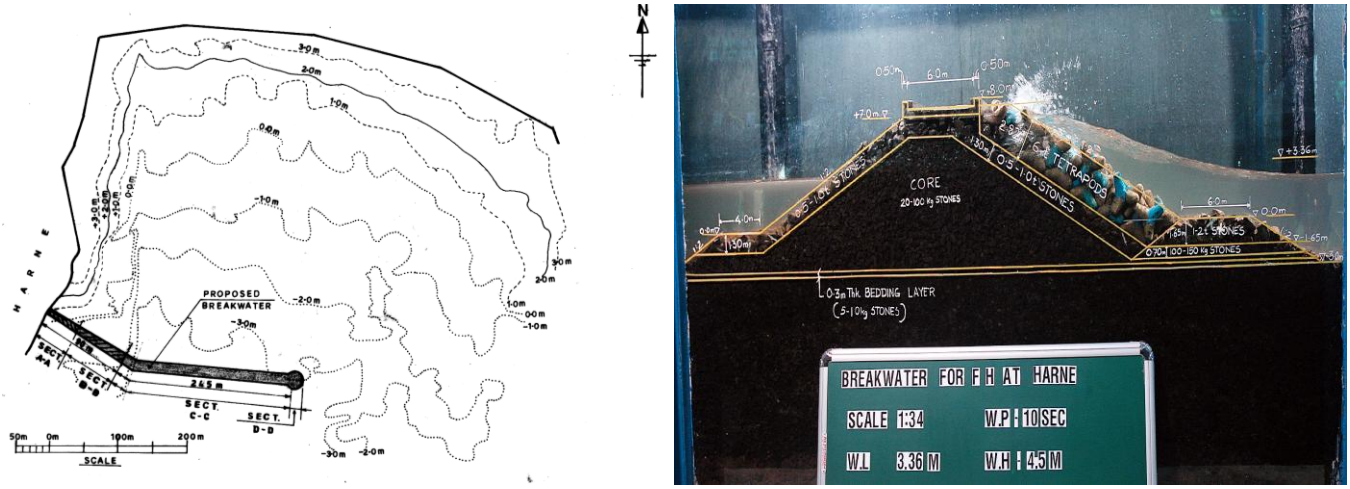
Distribution of BOD with proposed port



Distribution of Ammonia with proposed port

5214-DESIGN OF BREAKWATER FOR THE PROPOSED FISHING HARBOURAT HARNE IN MAHARASHTRA

The Commissioner of Fisheries, Government of Maharashtra has proposed to develop a fishing harbour at Harne in Ratnagiri District. Presently, a small jetty existing adjacent to the proposed development site is being used for the fishing activities. The layout for the proposed harbour was finalized by CWPRS vide Technical Report no.4493 dated October 2007 through mathematical model studies. The Commissioner of Fisheries, Government of Maharashtra referred studies for the design of breakwater cross-sections to CWPRS. The proposed layout consists of rubble mound breakwater of about 375 m long extending up to -3 m bed level. The cross-sections of breakwater were evolved at various bed levels through desk and wave flume studies. A design wave height of 4.5 m was considered for the trunk portion and the roundhead at -3 m bed level. Initially, a conceptual design was worked out using empirical formulae. The trunk portion consists of 2 t, 4 t, and 6 t tetrapods in the armour layer on 1:2 slope and the roundhead consists of 8 t tetrapods on 1:2 slope in the armour. The conceptual cross-section of trunk portion was tested in a wave flume with a Geometrically similar model scale of 1:34. The hydraulic stability of the cross-section was ensured for the design waves of 4.5 m height.



Design of breakwater for the development of fishing harbour at Harne

5216, 5217,5218-MATHEMATICAL MODEL STUDIES FOR THE PROPOSED DEVELOPMENT OF PORT FACILITIES AT SAGAR ISLAND , WEST BENGAL

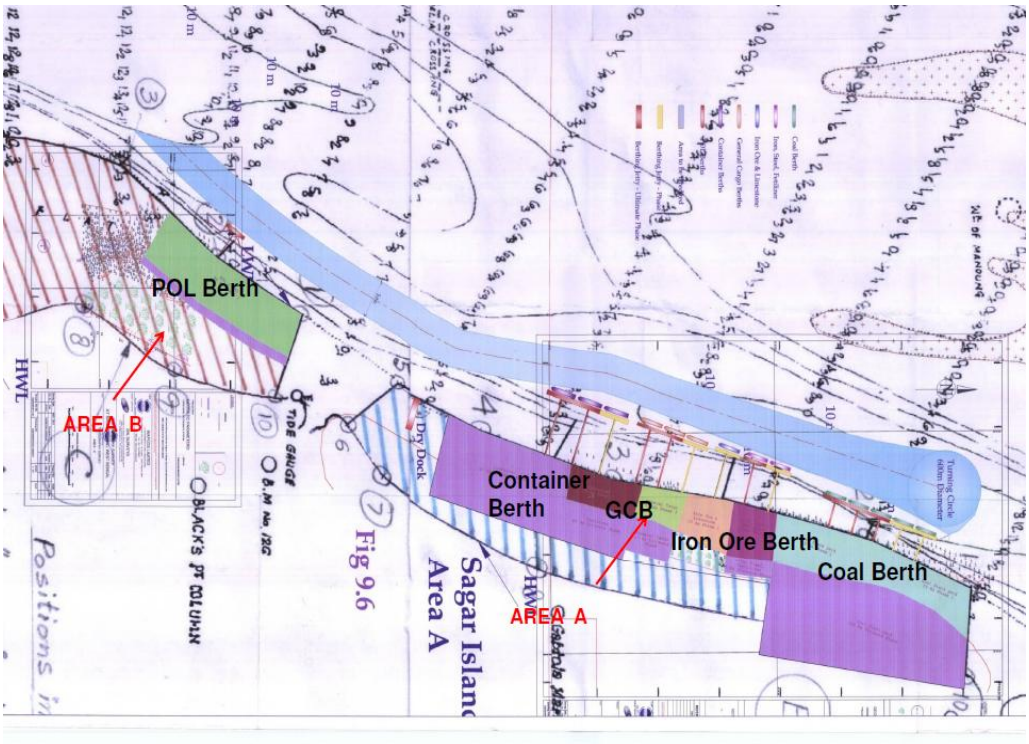
Sagar Island is situated near Kolkata in the mouth of Hugali River. Kolkata Port Trust have a proposal to develop a port on the western fringes of Sagar Island for handling vessels with a draft of 10.5 m for carrying liquid bulk cargo, such as POL, vegetable oil etc. and dry bulk cargo such as coking coal, thermal coal, coke, limestone, iron ore etc and the containers. The proposed development consists of deep navigation channel, a turning circle and various berths along the western shore of the Sagar Island. Various hydraulic model studies such as wave tranquility, ship maneuvering and ship mooring analysis were referred to CW&PRS to finalize the layout of the proposed port.

Analysis of the offshore wave data indicated that the predominant wave directions off Sagar Island are from WSW to SSE. For transformation of wave conditions to the proposed port location mathematical model MIKE21-SW was used. Wave transformation studies were carried out for incident wave directions SSE, South, SSW and SW and wave height of 4m. The studies indicated that wave heights in the turning circle would remain below the permissible wave height of 0.9m. However, for waves coming from SSW and SW directions the berths are exposed to high waves during high water. From the results of wave transformation and the analysis of offshore wave data, it was seen that wave heights in the port area would remain below the tranquility limit of 0.6m for about 95% of time of a year i.e. about 345 days in the northern area and about 92% of time of a year i.e. 335 days in the southern area. Considering the available depths in the proposed channel, use of tidal window for navigation may be necessary.

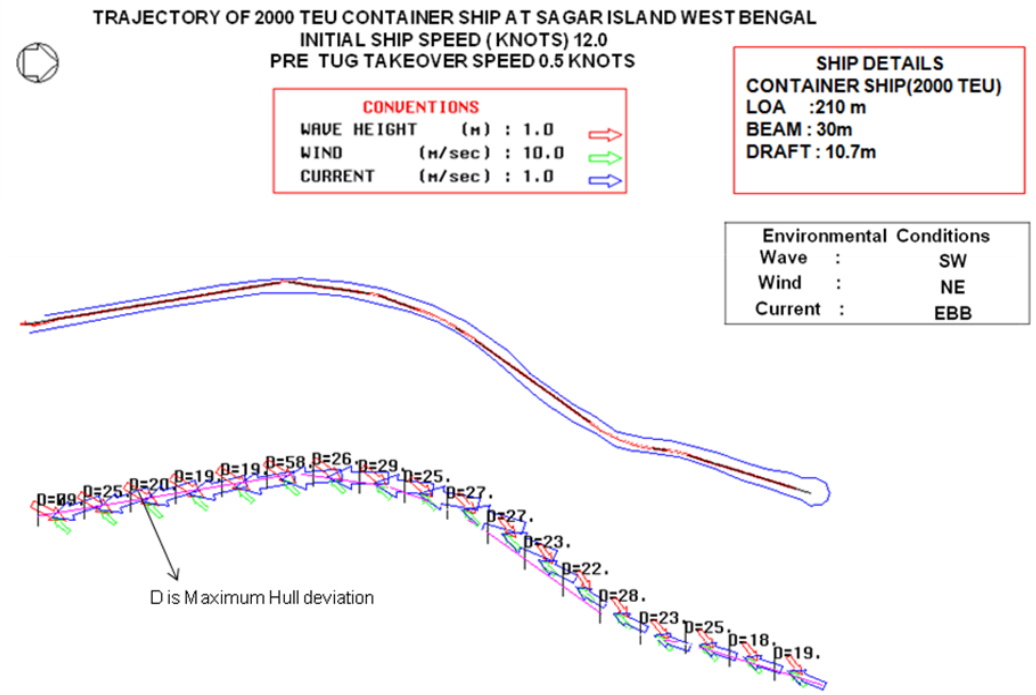
A container terminal and two oil jetties are proposed to be constructed in the New Port. In this regard, mathematical model studies for simulation of ship manoeuvring along the approach channel were carried out to assess the adequacy of the proposed channel. An approach channel with a base width of 300 m was proposed by M/s WAPCOS, the Consultants of the KoPT. Mathematical model NAVIGA was used for the simulations. The model predicts ship deflections under the forces of waves, winds and currents. Studies for the container ships of 2000 TEU under the prevailing winds, waves and currents indicated that the base width of 225m is sufficient for the safe manoeuvring of the design ship. Additional width of about 50 m would be required at the bend to negotiate the bend safely. Considering safety margin, a base width of 300m proposed by WAPCOS was found to be adequate for safe manoeuvrings of the design ship under the prevailing environmental conditions at the site.

Mathematical model studies were also carried out using the software OPTIMOOR for moored ship motions in six-degrees of freedom, rope tension, fender compression, bollard pull etc. for all type of ships at berth. Berthing energy was computed for each ship type and suitable fender system was suggested following the guidelines of Permanent International Association of Navigation Congresses (PIANC) and standard code of practices. Super Circle Fender (SPC 1200HFC96) or equivalent fender is found suitable to accommodate the berthing energy. The studies with ballast loaded and fully loaded conditions indicated that all the motions in four-degrees of freedom generated by ships are within operational limits. The maximum mooring loads and the corresponding percentage of breaking strength of rope are within the permissible limits and safe. The maximum mooring load occurred for Container ship in ballast loaded conditions is

13.1 ton which is equivalent to 23% of breaking strength. The SPC1200H fender can be compressed up to 74% of its height that is up to 0.88 m. The maximum compression felt for Container ship and POL ship is to 0.33 m. The maximum bollard pull exerted by Ore carrier and General cargo carrier is of the order of 27 tones. Therefore bollard of 100 ton can be installed with good factor of safety.



Port layout showing proposed berths

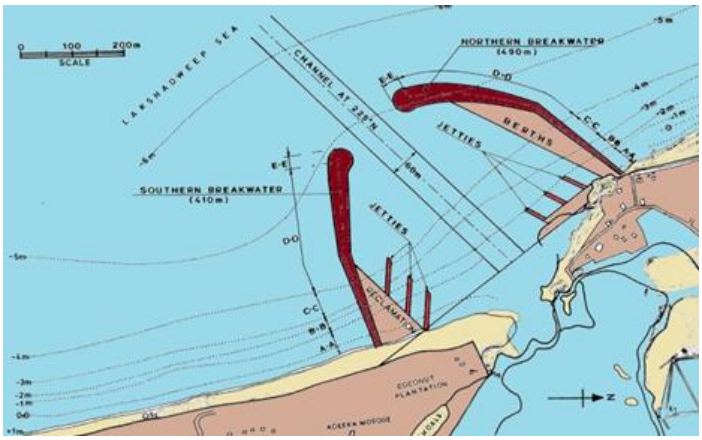


Trajectory of container ship, showing maximum hull deviation for waves from SW direction

5226-DESIGN OF BREAKWATERS FOR THE DEVELOPMENT OF FISHERY HARBOUR AT MANJESWARAM IN KASARGOD, KERALA

Manjeswaram is situated at the mouth of Uppala river & about 20 km south of Mangalore in Kasargod district of Kerala. Fishing is one of the main sources of livelihood of the people of Manjeswaram. The fishermen are facing difficulties in berthing operation due to assailing waves from the Arabian sea. Harbour Engineering Division (HED), Government of Kerala has a proposal of development of fishery harbor at Manjeswaram & referred various studies to CWPRS. The Mathematical studies carried out in CWPRS for Wave Tranquility, shoreline changes, hydrodynamics and siltation inferred the suitable layout of the proposed fishing harbor at Manjeswaram. The recommended layout consists of a shore connected north breakwater of about 490 m length and a shore connected south breakwater of about 410 m length. Both the breakwaters are extended upto -5.0 m depth contours.

Based on the site specific data regarding bathymetry, wave conditions and tidal levels, conceptual design of breakwater were worked out using the empirical methods. The hydraulic stability tests were conducted in the 40 m long regular wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:28. Two alternative cross-sections at -5.0 m bed level for trunk as well as for the roundhead with 3 - 5 t stones & 4 t tetrapods in the armour at 1:2.5 armour slope have been suggested. Five different cross-sections with respect to various bed levels have been suggested. The sections were found stable upto a design breaking wave height of 4 m, hence were recommended for construction.



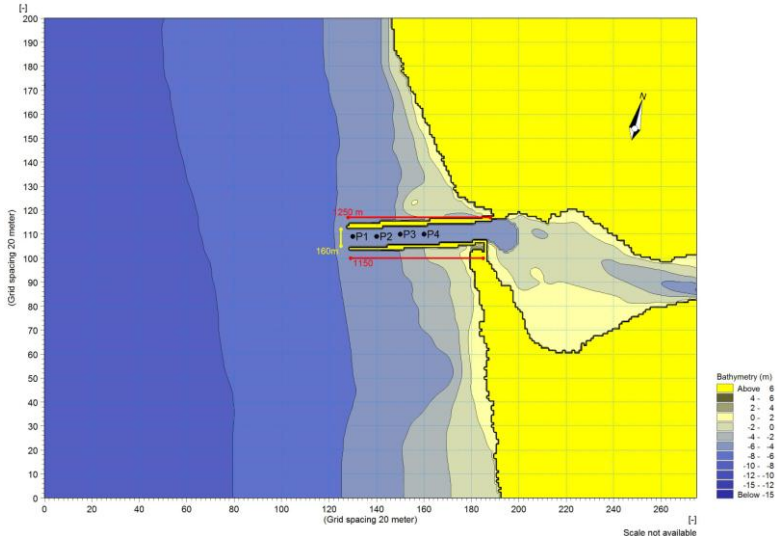
Layout of breakwaters

Wave flume test for breakwater

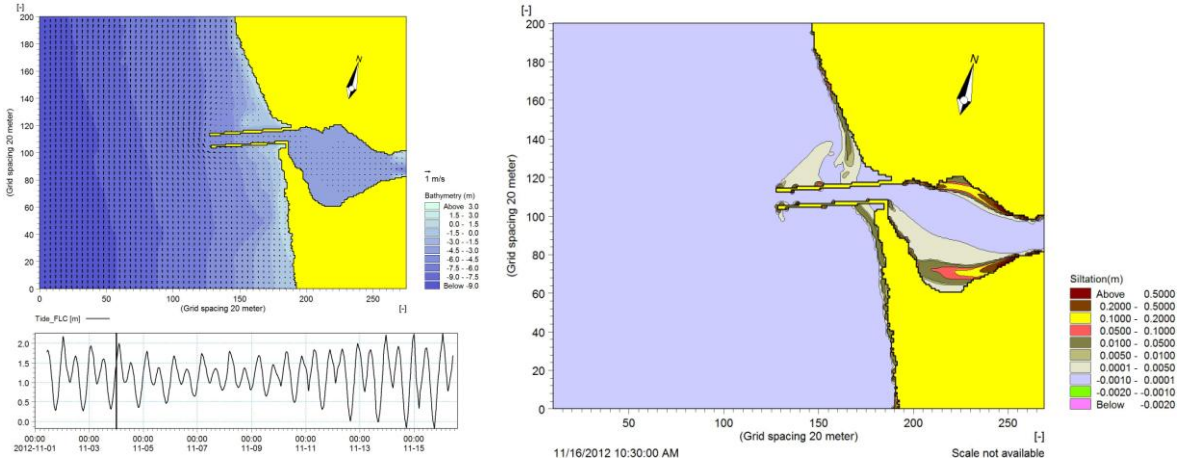
5229 -MATHEMATICAL MODEL STUDIES FOR THE DEVELOPMENT OF FISH LANDING CENTRE AT MANJAGUNI IN UTTARAKANNADA DIST, KARNATAKA

Port Division, Karwar, Government of Karnataka have a proposal for development of fish landing centre at Manjaguni, for providing berthing facilities for fishing boats. In this regard the Executive Engineer, Port Division – Karwar, Karnataka referred the mathematical model studies to CWPRS to examine the feasibility of development of fish landing centre at Manjaguni.

The proposed fish landing centre is located in the inlet connecting to the open sea and sufficient landing space is available inside the inlet. Manjaguni lies on the coast of the Arabian Sea and on the banks of the river Gangavalli. Presently Manjaguni Jetty is under construction. Mathematical model studies were carried out to assess flow field and sedimentation pattern in the proposed site with three alternative parallel breakwaters of length 1250m on northern side and 1150m on southern side at the inlet of river Gangavalli. From the hydrodynamic studies it can be concluded that the flow field is conducive with all the three proposals and without significant circulation. But with Proposal – III consisting of parallel breakwaters with 140m opening and dredging the channel and basin to -3m the current magnitude in the channel has increased. The annual deposition of siltation is expected, as the velocities are weak compared to the existing condition at the fish landing area. This tendency of sediment deposition in the harbor basin needs to be tackled by maintenance dredging. The frequency of maintenance dredging may be decided by regular monitoring of the sedimentation pattern post construction of fish landing facility at Manjaguni Jetty. Hence, based on the model studies it is recommended to adopt Proposal III for the development of fish landing jetty.



2- D computational model showing ***bathymetry***

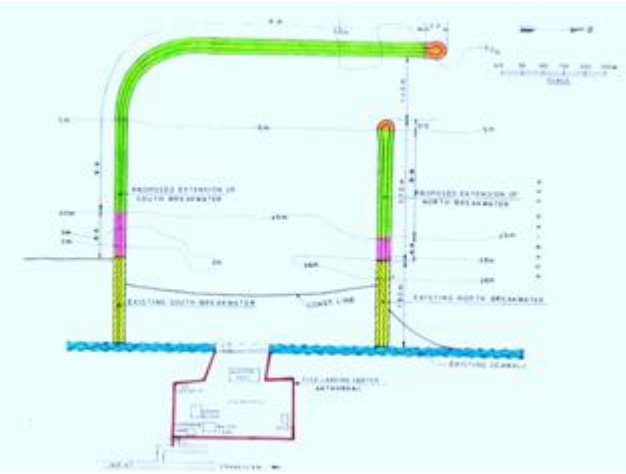


Flow field and sedimentation pattern with proposal III

5236-DESIGN OF BREAKWATERS FOR THE DEVELOPMENT OF FISHERY HARBOUR AT ARTHUNKAL IN ALAPPUZHA, KERALA

Arthunkal is a coastal village situated about 35 kilometers south of Cochin, in the Alappuzha district of Kerala state. The coast at Arthunkal is engaged in fishing activity. Fishing is one of the main sources of livelihood of the people of Arthunkal. The fishermen are facing difficulties in berthing operation due to assailing waves from the Arabian sea. Harbour Engineering Division (HED), Government of Kerala have a proposal of development of fishery harbor at Arthunkal & referred desk & wave flume studies for the hydraulic stability of the breakwaters to CWPRS. The Harbour Engineering Division, Kerala already constructed 190 m long south and north breakwaters at Arthunkal. The referred layout consists of extension of northern breakwater & southern breakwater of about 310 m and 1110 m respectively. The northern breakwater are extended upto -5.0 m depth contour & southern breakwater is extended upto -5.5 m depth contour.

Based on the site specific data regarding bathymetry, wave conditions and tidal levels, conceptual design of breakwaters were worked out using the empirical methods. The hydraulic stability tests were conducted in the 40 m long regular wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:28. Two alternative cross-sections at -5.5 m bed level for trunk as well as for the roundhead with 3 - 5 t stones & 4 t tetrapods in the armour at 1:2.5 armour slope have been suggested. Three different cross-sections with respect to various bed levels have been suggested. The sections were found stable upto a design breaking wave height of 4 m, hence were recommended for construction.



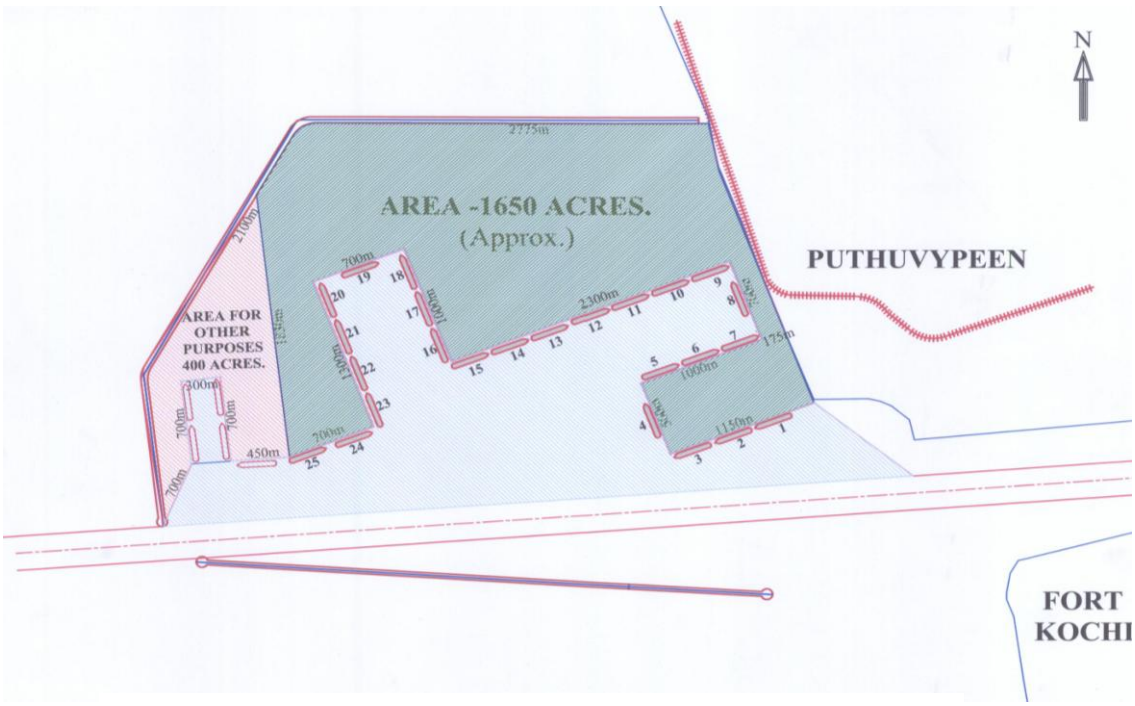
Layout of breakwaters

Wave flume test for breakwater

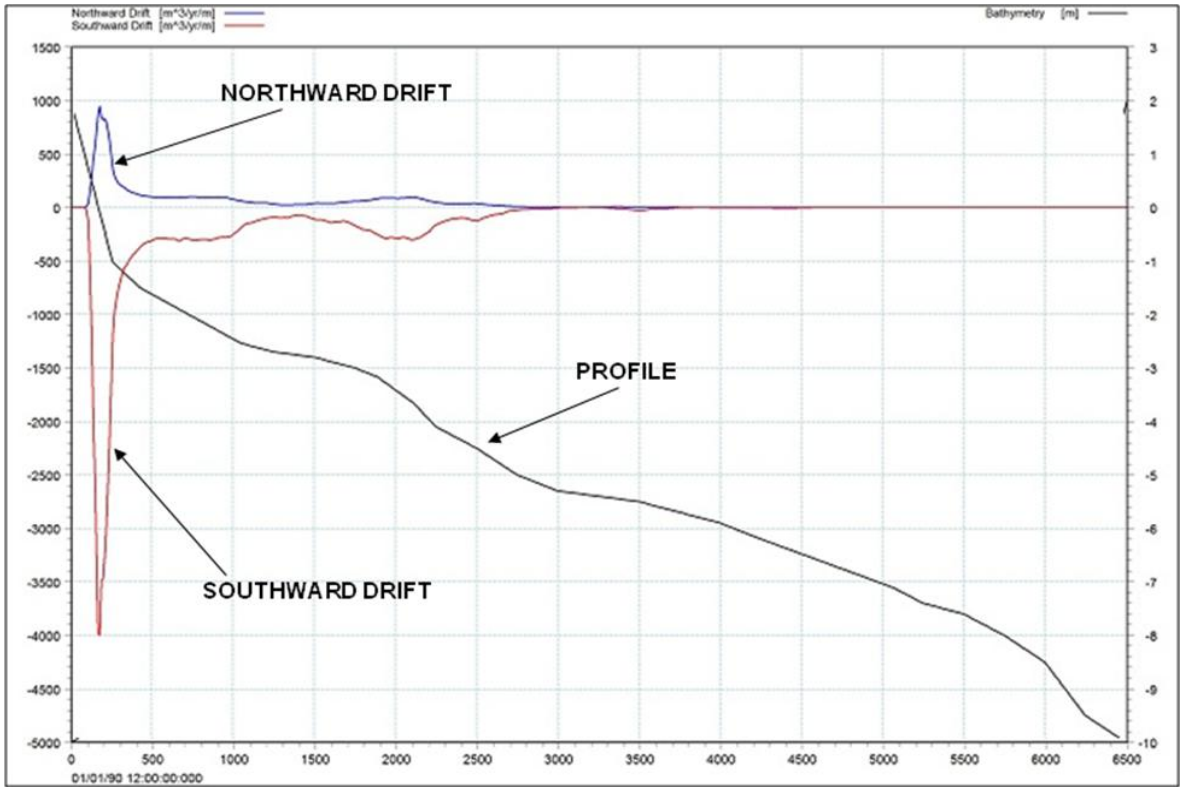
5238-MATHEMATICAL MODEL STUDIES FOR LITTORAL DRIFT, SHORELINE EVOLUTION AND MITIGATION MEASURES FOR OUTER HARBOUR AT KOCHI FOR COCHIN PORT TRUST, KERALA

In order to handle liquid cargo consisting of LNG/LPG, crude oil, POL products, chemicals etc, Cochin Port Trust has proposed to develop an outer harbour at Cochin on the west coast of India, Kerala. As the area is exposed to open sea, a layout consisting of 6676 m long shore connected north breakwater and 4472 m offshore south break water have been proposed by the Cochin Port Trust (CoPT). As the area of outer harbour is exposed to open sea, to achieve the desired wave tranquility and to ensure desirable flow field, the layout consisting of breakwaters on the north side and south side of the approach channel is proposed, which is considered for mathematical model studies of littoral drift distribution and shoreline changes using LITPACK software.

Analysis of wave climate during the entire year period indicates that the predominant wave directions are from West and WNW with the maximum wave height of the order of 3.5 m and the percentage occurrence of 30% and 32% respectively. Further, based on the simulation of littoral drift, the annual net and the gross transports were estimated to be of the order of 1.19 and 0.66 million m^3 respectively. The net transport is towards south. Shoreline evolution studies were carried out to examine the likely changes in coastline due to the proposed layout of the outer harbour. Based on the studies, the longshore effect of deposition was felt for a length of about 4550 m and similarly longshore effect of erosion was felt for a length of about 6250 m. The maximum cross-shore advancement of the shoreline in 10 years period would be of the order of 390 m. In order to avoid erosion on the south side, appropriate protection work would be essential. In some of the reaches like the coastline of INS Dronacharya, the protection works are already provided.



Layout of outer harbour at Cochin

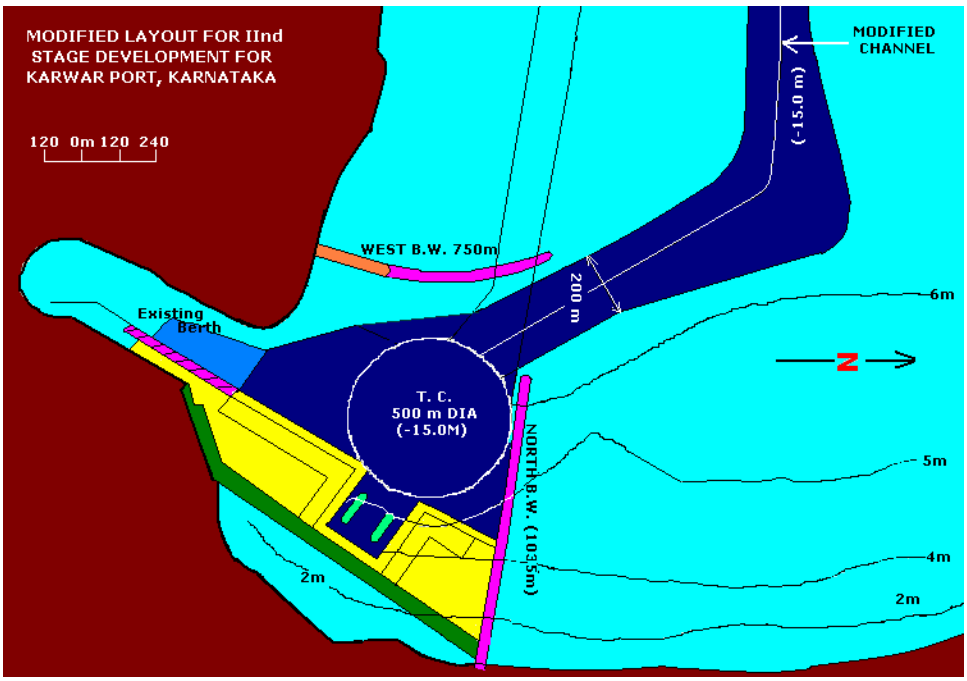


Cross-shore distribution of littoral drift for annual period

5239-WAVE TRANQUILITY STUDIES FOR 2ND STAGE DEVELOPMENT OF KARWAR PORT, KARNATAKA

The Karwar port located on the west coast of India at about 70km south of the Mormugao port has been in operation since the year 1995-96. The present port layout consists of 2 berths in the Baithkol bay and a western breakwater of 250m length. The development area is located between the Lat 14^0 47′ N - Long 74^0 06′ E and Lat 14^0 49′ N- Long 74^0 09′ E. Karwar Port authorities propose 2nd stage development to increase port turnover to 6-7MT from the present 1MT. The original layout for 2nd stage development as proposed by the Port authorities involved extension of existing western breakwater by 238m and construction of new northern breakwater of 1200m length and new 4-5 berths with vertical face to cater to Panamax size vessels of size 60,000 DWT. This development also involved dredging a 200m wide approach channel to a level of (-) 15.0m below char datum with port entrance towards west direction. The permissible limit of the wave tranquility at all berths was considered as 0.50m suitable for the Container ships.

The wave tranquility aspects for 2nd stage development were studied using the physical model with geometric similar (G.S.) scale of 1:120. The model studies were conducted by reproducing predominant random incident waves of Hs = 3.6m and Tp = 10.0 sec from the West direction corresponding to the southwest monsoon season and Hs = 1.5m and Tp = 6 sec from the Northwest direction corresponding to non monsoon season using the multichannel data acquisition system. The model studies indicated that the adequate wave tranquility would not be achieved with the original layout at least at four berths facing the port entrance and a loss of 30 operational days in the monsoon season and 7 days during non monsoon was envisaged. In order to improve the wave tranquility at the exposed berths, it was considered to shift the port entrance to northwest direction which is exposed to the much lesser wave heights in comparison to the waves from the west direction and this way, it would offer more protection to the exposed berths and recessed basin. The suggested configuration in modified layout would consist of new northern breakwater of length reduced to 1035m and existing western breakwater will be extended upto 750m with port entrance oriented in the northwest direction. The overall increase of 100m in length breakwater in the modified layout in comparison to the original layout would provide adequate wave tranquility at all berths throughout the year. The stone pitching at a slope 1:2 was recommended for exposed berthing faces to avoid undue wave reflections. The approach channel would be required to be shifted laterally towards north by 720m by providing suitable bend and the ship maneuvering and navigation aspects need to be studied separately.

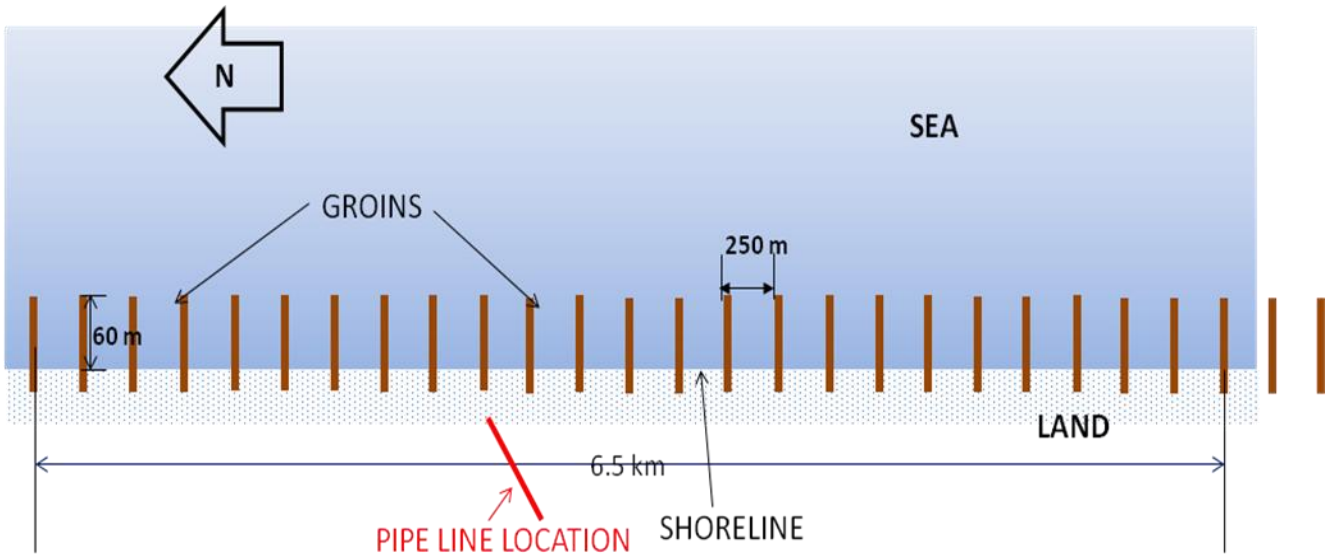


Modified layout for 2nd stage development of Karwar port

5242-MATHEMATICAL MODEL STUDIES FOR SHORELINE CHANGES AT ONGC PLANT AND PIPE LINES NEAR ODALAREVU VILLAGE, EAST GOVDAVARI, ANDHRA PRADESH

Mathematical model studies were carried out at CWPRS for shoreline changes at ONGC plant and pipe line near Odalarevu village, Andhra Pradesh. A pipeline has been laid by ONGC in order to deliver mixed material from offshore well to the separation plant. The coast at Odalarevu has suffered progressive erosion for the last decade. In this regard, DGM (Civil), ONGC , Odalarevu referred studies to CWPRS to suggest remedial measures to combat the progressive erosion at the coast. Mathematical model studies for estimation of littoral drift distribution and simulation of shoreline changes were carried out using LITPACK model.

LITDRIFT module of LITPACK software was used to estimate annual littoral drift rates and its distribution on the profile normal to the shoreline The studies indicated that, net transport in a year is of the order of 0.39million cum and is towards north and gross transport is of the order of 0.5 million cum. The maximum transport occurs at about 300 m from the shore at around 1.85m depth contour. In order to protect the stretch of the shoreline in front of the pipeline ,four combinations of coastal structures consisting of series of groins and offshore breakwaters were considered for the simulation studies. The simulation studies for shoreline evolution indicated that provision of series offshore breakwaters in 4m depth, will provide better protection to the coastal reach,. However, from considerations of difficulty in construction of the breakwaters in 4m depth, it was suggested to provide a series of twenty seven number of groins , each of length 60m. Measured wave data of at least one year at the site , which is an important input data for the model studies, were not available. In the absence of the measured wave data derived wave data in deep sea from CWPRS data bank was used. Therefore predictions about the shoreline changes are to be considered as only indicative and it was suggested to start the construction of the groins form the north end of the coastal stretch, initially with construction of two to three groins and observe the effect of construction of these groins on the adjacent coastline. The construction of the groins can be proceeded on the southward shoreline in phases.

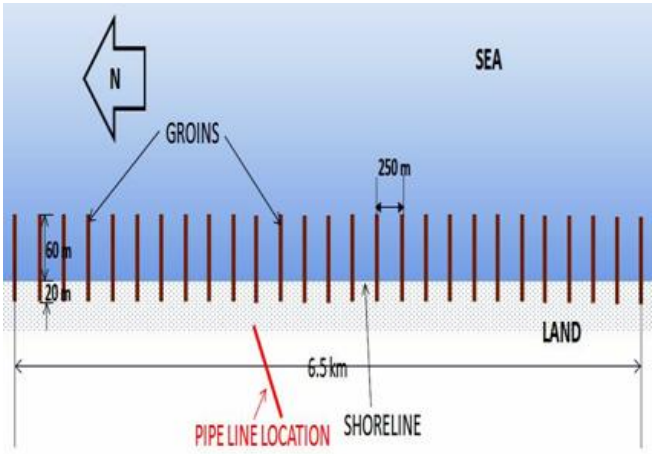


Schematic representation of arrangement of groins

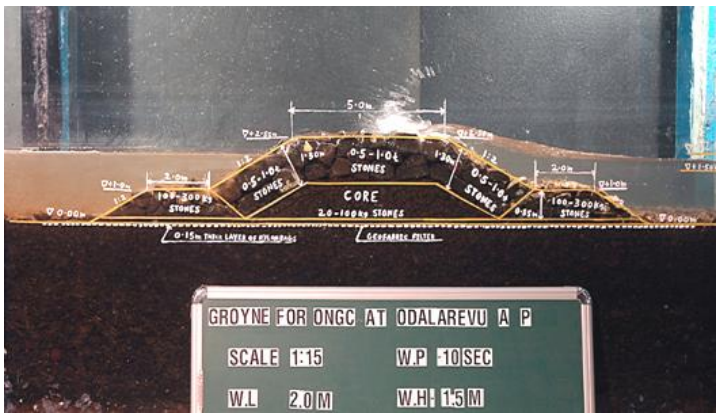
5243-DESIGN OF COASTAL PROTECTION WORKS AT ONGC PLANT & PIPELINE NEAR ODALAREVU, EAST GODAVARI DISTRICT, ANDHRA PRADESH

Oil & Natural Gas Corporation Limited (ONGC) have an established terminal for the separation of crude oil, CNG & water at Odalarevu village at about 80 km south of Kakinada in East Godavari district of Andhra Pradesh. The coast at Odalarevu suffered cumulative erosion from last decade and the coastal erosion has been aggravated from the last couple of years. DGM (Civil) Odalavaru referred mathematical model studies for shoreline changes, shoreline stability studies using remote sensing and desk & wave flume studies for the design of coastal protection works. The objective of the protection measures is to secure existing as well as proposed pipeline from the probable erosion of the coast. It also includes protection of the adjacent coastline on either side of the pipeline.

The recommended layout consists of 27 Nos. of rubblemound parallel groynes with 80 m length each and a spacing of 250 m, provides protection to the coastline of about 6.5 km length. Based on the site specific data regarding beach profiles, wave conditions and tidal levels, conceptual design of groyne were worked out using the empirical methods. The hydraulic stability tests were conducted in the wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:15. The cross-section of the trunk portion of the groyne consisting of 0.5 to 1 t stones in the armour placed at 1:2 slope has been evolved from root to 0.00 m bed level. The cross-section of the roundhead portion of the groyne consisting of 1 to 2 t stones in the armour placed at 1:2 slope (at -0.50 m bed level) has been suggested. The sections were found stable upto a design breaking wave height of 1.5 m, hence were recommended for construction.



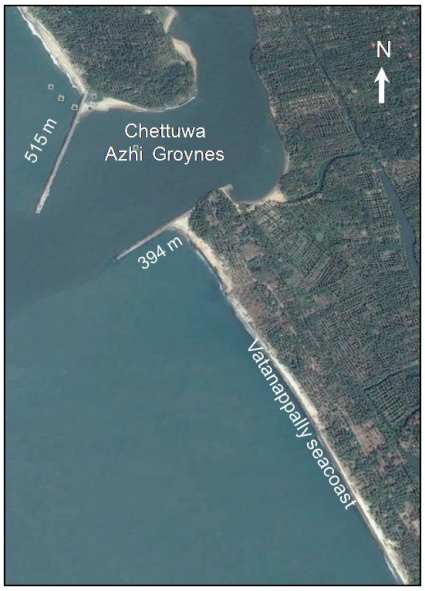
Layout of groyne field



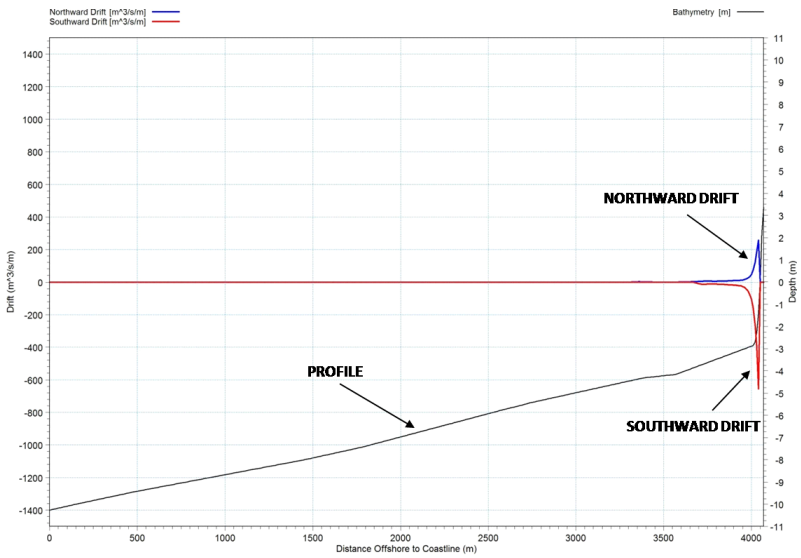
Wave flume test for groyne

5247-MATHEMATICAL MODEL STUDIES FOR LITTORAL DRIFT AND SHORELINE CHANGES AT VADANAPILLY PANCHAYAT, KERALA

Coastal stretch located near Vatanappally Panchayat (Lat. 10°28′0″N and Long. 76°5′0″E) of Thrissur district in Kerala state has become vulnerable to erosion due to the changed behaviour of the sea along the coast causing strong waves in the area. Out of the total length of about 8.35 km between CP 1341 and CP 1380, about 4.50 km length is protected by seawall and the rest 3.85 km length remains unprotected. Strong waves generally overtop the existing seawall causing partial damage to it at several locations. Besides, the sea erosion struck at the unprotected reach resulting in eroding of the land mass. The affected areas require strengthening of protection works. In order to protect the unprotected reach and further for strengthening of the existing seawall, mathematical model studies have been carried out to access littoral drift distribution and changes in shoreline using LITPACK software for the vulnerable coastal reach of Vatanappally Panchayat. Analysis of wave climate during the entire year period indicates that the predominant wave directions are from West and WNW with the maximum wave height of the order of 3.5 m and the percentage occurrence of 26% and 20% respectively. Further, based on the simulation of littoral drift, the annual net and the gross transports were estimated to be of the order of 0.0122 and 0.0328 million m^3 respectively. The net transport is towards south. Shoreline evolution studies were carried out to examine the likely changes in coastline due to the proposed extension of the existing seawall under the proposed condition. The model exhibited reasonably small extent of erosion both in cross-shore and in longshore directions. A combination of seawall and a series of 20m long groyes (spaced at 100m) has been suggested as coastal protection measure for the Vatanappally coastal reach.



Aerial picture of existing breakwaters at Chettuwa Azhi



Cross-shore distribution of littoral drift for annual period

5248-MATHEMATICAL MODEL STUDIES FOR THE DEVELOPMENT OF FISHING HARBOR AT BHATKAL IN UTTARAKANNADA DIST, KARNATAKA

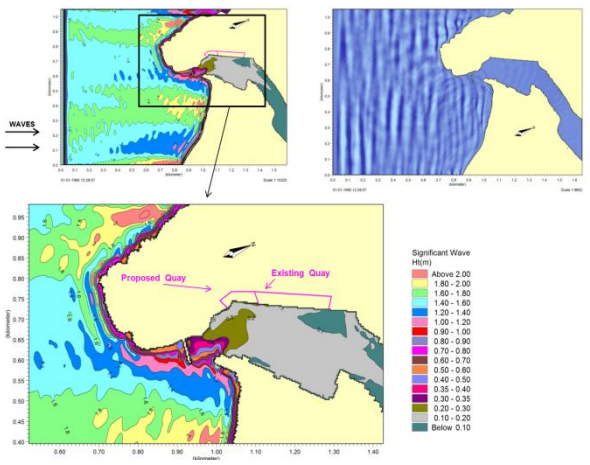
Bhatkal lies on the coast of Karnataka on the banks of the river Chawtani, which flows in the south west direction to meet the Arabian Sea. Port Division, Karwar, Government of Karnataka have a proposal for further development of the existing fishing harbor by extending quay length from 185 m to 285 m for additional berths for fishing boats. Breakwater is proposed on the western side i.e opposite to the existing south break water at the river mouth to dissipate the wave energy from South and SSW direction. In this regard the Executive Engineer, Port Division – Karwar, Karnataka referred mathematical model studies to CWPRS for examining the feasibility of proposed developments at Bhatkal fishing harbor.

The following model studies were carried out, at CWPRS for different alternatives of harbour layouts:

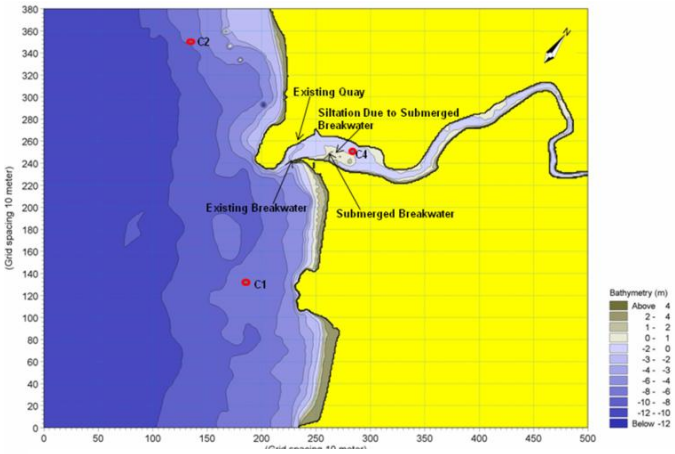
- Mathematical model studies for wave tranquility
- Mathematical model studies for tidal hydrodynamics and siltation

Wave propagation studies with MIKE21-SW model, for transformation of deep water wave conditions to 10 m depth in the nearshore area of Bhatkal Harbour, indicated that the predominant wave directions are from SSW, SW, WSW, West and WNW. Wave propagation studies carried out with MIKE21-BW model, to assess wave tranquility inside the harbour indicated that, in the existing condition, wave heights would remain within the permissible wave height of 0.3m for about 324 days in a year, including 87 days in SW monsoon. Layout with 40m breakwater provides wave tranquility of 356 days in a year, including 118 in SW monsoon. It is seen that layout with breakwater of 60 m length improves the tranquility near the proposed extension of quay marginally. Traditionally fishing activity is carried out during non monsoon season and part of south-west monsoon (August and September), therefore a western breakwater of 40m or 60m length would help marginally in achieving the desired wave tranquility in the harbour. Hence, it is recommended to go with the proposal of extension of quay by 100m without any additional breakwater.

The Hydrodynamic studies indicated that with the proposed extension of the existing quay by 100m and introduction of 40m or 60m western breakwater does not have much impact on the overall flow field. The flow conditions are conducive without any adverse circulations or eddy formation.
Similarly the sedimentation study with all the proposals indicated adverse impact in the form of increasing the sedimentation at the harbor entrance when compared with the existing sedimentation pattern. As such the provision of additional Western breakwater of 40m or 60m does not serve any purpose of either altering the flow conditions or sedimentation pattern. Hence, it can be concluded that the extension of the existing quay by 100m towards the sea side can be undertaken safely. It is also suggested to strengthen the existing breakwater. As the tendency of sediment deposition at the river mouth is expected. It is suggested to tackle it with regular maintenance dredging.



Wave propagation and height distribution (existing)(waves incident from SSW direction)

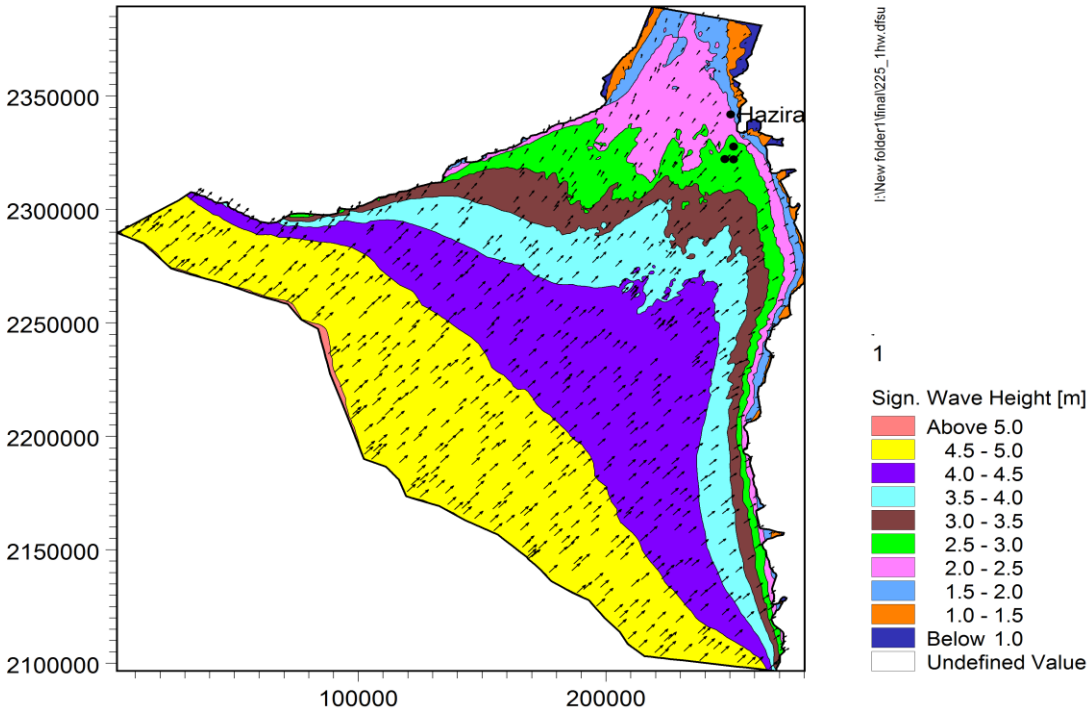


2-D view of computational model

5250-MATHEMATICAL MODEL STUDIES FOR WAVE TRANSFORMATION FOR THE PROPOSED DEVELOPMENT OF PORT FACILITIES AT HAZIRA, GUJARAT

Reliance Industries Ltd have a proposal for development of a coal jetty for setting up a coal fired power plant at Hazira, Gujarat. In this regard M/s WAPCOS referred mathematical model studies to CWPRS for assessment of wave conditions near the proposed site of development. Accordingly mathematical model studies for wave transformation were undertaken at CW&PRS to determine feasibility of all weather operations at the jetty.

The offshore wave data reported by India Meteorological Department (IMD) as observed from ships plying in deep waters off Hazira were analysed and used as input wave data for the wave transformation studies. For simulation of wave transformation from offshore to the proposed port location at Hazira, mathematical model MIKE21-SW was used. The analysis of IMD data indicated that the predominant directions off Hazira are from SW, WSW and West with occurrence of 11%,16% and 19 % in a year respectively. The tidal range at Hazira is high and is of the order of 7.8m during spring tide. Due to presence of shoals dissipation of wave energy takes place and at low water, significant reduction in wave height is observed at Suvali point in the absence of effect of local wind. However, local wind prevailing in the domain contributes to increase in wave heights at the proposed site of port development. From the mathematical model studies it was observed that the maximum significant wave height at Suvali is of the order of 2.1m. At anchorage location the maximum significant wave height is of the order of 2.7m.

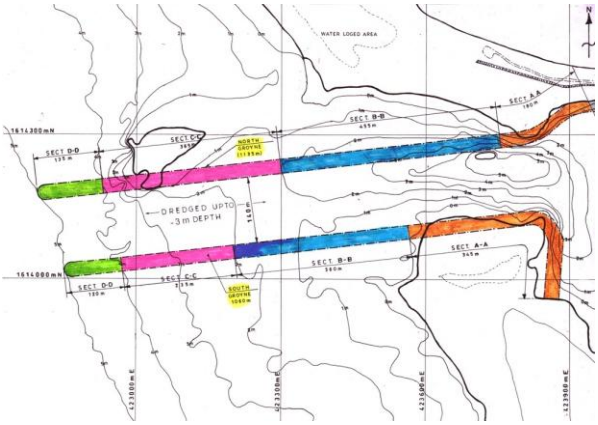


Wave height distribution for incident wave height of 5m at the proposed development at Hazira for waves from SW direction

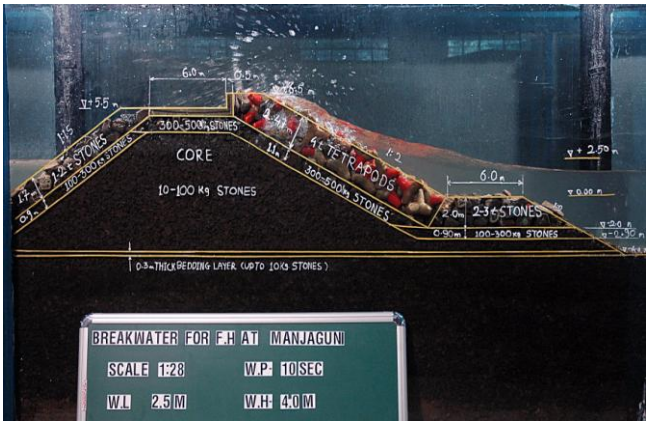
5251-DESIGN OF TRAINING WALLS/ GROYNES FOR THE DEVELOPMENT OF FISHERY HARBOUR AT MANJAGUNI, KARNATAKA

Manjaguni is a coastal village located on the west coast of India in Uttar Kannada District of Karnataka. The proposed site for the development of fishery harbour at Manjaguni, situated on either side of the banks of the Gangavalli river mouth of the Arabian Sea. Heavy deposition of sediments is experienced at the mouth during non-monsoon, thereby decreasing the waterway to a great extent. The Fishermen are facing difficulty in navigating the vessels due to narrow entrance and shallow depths at the mouth. Government of Karnataka has a proposal for the development of fishery harbour and to assure the navigation through the inlet for the fishing boats. Executive Engineer, Ports and Inland Water Transport, Karwar, requested CWPRS to conduct studies for maintenance of tidal inlet. In order to understand the flow conditions and sediment movement, hydraulic model studies were carried out at CWPRS. The hydrodynamic behavior of flow conditions and siltation pattern were studied using mathematical model and reported in CWPRS Technical Report no. 5229. The length and alignment of two parallel training walls / groynes at the entrance provided up to -5 m bed level, to guide the flow and maintain the depths for navigation of fishing vessels have been finalized through mathematical model studies. The clear spacing between two training walls/ groynes is about 140m oriented at 264° with respect to North to guide the flow. Dredging upto -3 m depth was also suggested inside the channel for the safe navigation of the boats.

Desk and wave flume studies are carried out to evolve the design of cross-sections of bank protection and training walls/groynes at various bed levels. Based on the site specific data regarding bathymetry, wave conditions and tidal levels, conceptual design cross-sections of bank protection and training walls / groynes evolved at various bed levels were worked out using the empirical methods. The hydraulic stability tests were conducted in the wave flume by reproducing the sections to a Geometrically Similar (GS) model scale of 1:28. The cross-section of training walls / groynes consists of 2 t tetrapods in the armour placed at 1:2 slope from 0.0 m to - 2.0 m bed level, 4 t tetrapods in the armour from – 1 to - 2 m bed level, 4 t tetrapods in the armour from - 2 m to - 4 m bed level, 5 t terapods in the armour for roundhead portion at - 4 m bed level. A bank protection work is suggested inside the channel consists of 0.5 to 1.0 t stones placed at 1:2 armour slope. The sections were found stable upto a design breaking wave height of 4.5 m, hence were recommended for construction.



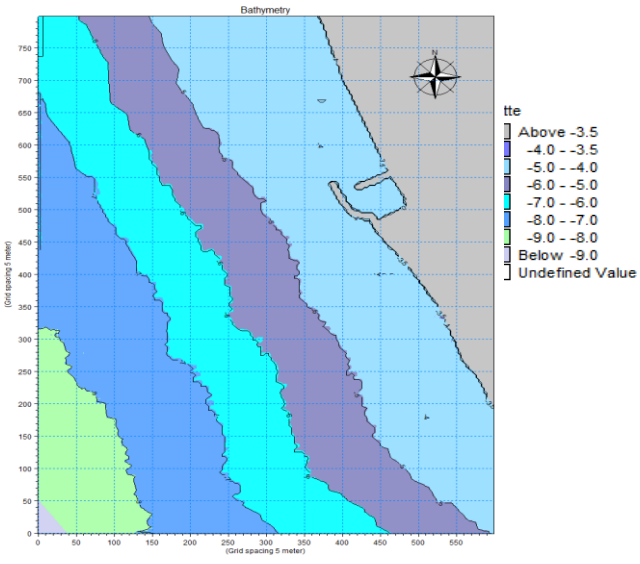
Layout of training walls/groynes



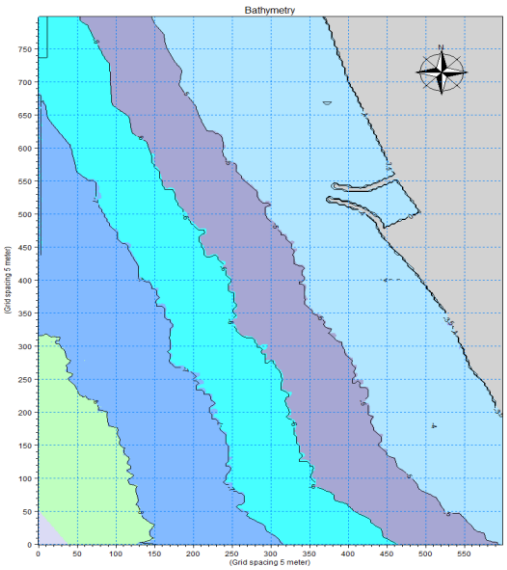
Wave flume test for hydraulic stability

5252-MATHEMATICAL MODEL STUDIES FOR ASSESSMENT OF WAVE TRANQUILITY AND SHORELINE CHANGES FOR THE PROPOSED DEVELOPMENT OF MINI FISHING HARBOUR AT THOTTAPPALLY, KERALA

Mathematical model studies carried out at CWPRS for assess wave tranquility to examine the adequacy of the proposed layout of the fishing harbor to provide desired tranquility in the harbor and also for prediction of shoreline changes in the vicinity of the harbor. Harbour Engineering Department, Kerala (HED, Kerala) have a proposal for development of a Fishing Harbour at Thottappally, Kerala. Existing harbor is facing problem of sever siltation in the harbor. In this regard, the Chief Engineer, Harbour Engineering Department, Kerala referred the studies to CWPRS to suggest modifications to the existing harbor layout to minimize the problem of siltation in the harbor. The existing harbor layout consists of two breakwaters; north breakwater of 145m length and south breakwater of 476m length. HED, Kerala have proposed modifications to the existing harbor layout. The proposed layout consists of Northern breakwater of 250m and southern breakwater of 816m (476 + 340) length each having a clear gap of 120m in between them. The exiting harbor at Thottappally is subjected to siltation inside the basin due to passage of northward littoral drift through the harbor entrance. In the layout proposed by HED, Kerala, though the southern breakwater is extended, after two to three years the shoreline will advance and the drift will again start entering the harbor basin. Therefore, modifications to this harbor layout are suggested to minimize the drift entering in the harbor. With the modified layout it was observed that sand bypassing towards north will reduce. The wave tranquility studies showed that the modified layout is adequate to provide desired tranquility in the harbor basin. The existing sea wall on the northern side of the port needs to be repaired and maintained to provide protection to this reach of the coastline.



(a) Proposed Harbour Layout



(b) Modified Harbour Layout

5253-MATHEMATICAL MODEL STUDIES FOR MINIMISATION OF SILTATION AT QUAYSIDE OF COCHIN SHIPYARD, COCHIN

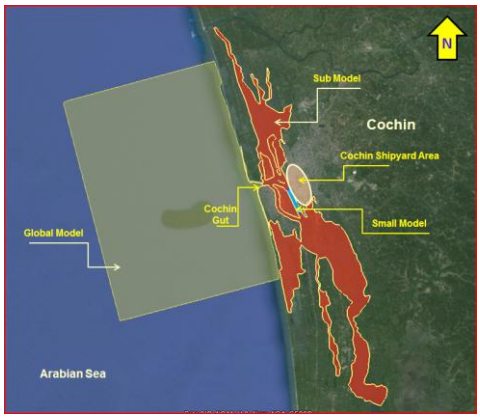
M/s. Cochin Shipyard Limited (CSL) a premier green field shipyard of India is situated in Ernakulam channel at Cochin at latitude 9^0 57 ′14″ North and longitude 76^0 17′ 22″ East. The shipyard is carrying out the building & repairs of ships for many organisations for the past four decades. The shipyard is situated well inside in Eranakulam channel at Cochin and has two dry docks for ship building/repairs with total quay length of about 1300 m. The ships built at shipyard are taken out of dry docks and are berthed along quay for carrying outfitting. The location of shipyard being well inside from gut location at Cochin, it is free from sea wave disturbance. However, the quay side at CSL maintained to a depth of about 6-7m below CD is subjected to high rate of siltation of about 3-3.4m/annum. This results in problem for deberthing of ship after outfitting as well as entry of ship in dry dock. The siltation during monsoon is more and is about 60-70% of annual. The tidal phenomenon in association with freshet discharges from backwaters is a dominant mechanism of hydraulics prevailing at Ernakulam channel. M/s. CSL is building mega ship like aircraft carrier for Indian Navy which will be berthed at quay wall for outfitting for much longer duration of about four years; in order to avoid problem of deberthing by minimising siltation along quay wall, studies were entrusted to CWPRS. The two options to minimise siltation viz. option-I as a short term measures for Mega ships like aircraft carrier and option-II, a long term measure for general types of ship are under considerations.

The solution to the problem of siltation at CSL is evolved using mathematical model studies. The area of Cochin harbour consists of meeting of various channels such as Ernakulam, Mattanchery; presence of various islands/reclamations, bridges etc; triangular Finite Element technique with variable mesh size was considered for carrying out mathematical model studies. The models such as global and sub developed are shown in Fig-1, wherein global model is used for hydrodynamics, while based on flow hydrodynamics a sub model is used for evolving siltation & its minimising at CSL quay wall.

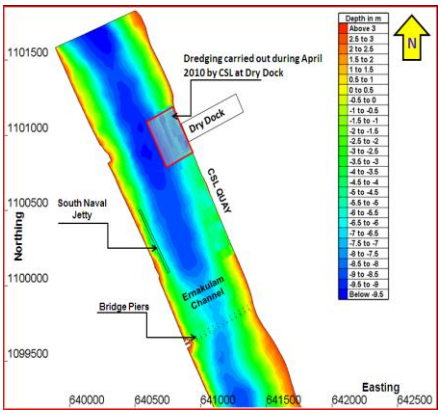
The field data on oceanographic parameters for both the seasons i.e. monsoon and non-monsoon collected for the studies was used for calibrating/proving the hydrodynamic/silt model. The information on existing rate of siltation for quay wall provided by CSL was used for calibrating the silt model.

In minimising siltation at quay wall of CSL, Option-I as a short term measure with area around aircraft carrier deepened to 7m below CD and traps dredged to 10m depth on both ends were studied along with the various configurations of sheet pile wall structures. The three alternatives were studied and it reveals that Alternative-III consisting of dredged traps and three sheet pile wall structures minimizes the siltation at CSL significantly (42%) compared to that with the existing and as such seems to be more promising to minimize the siltation for mega ships like aircraft carrier. In case of long term measures the dredging all along the quay wall to a depth of 7m below CD with traps dredged at many locations (10 m below CD) along quay with parallel sheet pile wall structures were considered. In all four alternatives [Alt. (a) to (d)] were studied to minimize siltation at quay wall. The studies carried out for various alternatives revealed that the Alt. (d) seems to be more promising in minimizing the siltation (38%) at quay wall with added advantage of avoiding dredging by one year in traps for berthing general type of ships and as such is more useful as a long term measures for minimizing the siltation at quay wall. The solution found to be more effective for short term and long term are shown in Fig.2

The literature on method of controlling sedimentation along quay wall using scour-jet array system adopted in USA for the naval facility at Mare Island, Vallejo, California is given. The design of such system being site specific, after careful investigation of various parameters, similar technique/method can also be tried as a pilot project for minimising siltation as a long term measure.



(a) Global model



(b) Sub-model

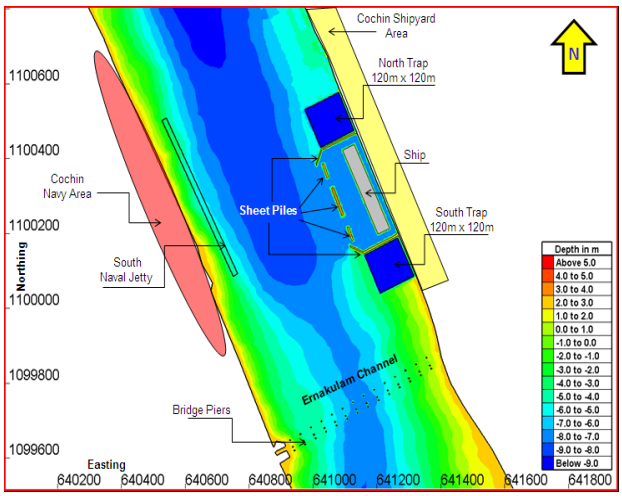
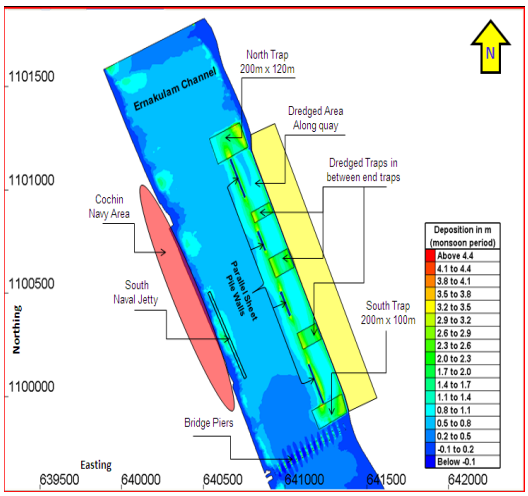


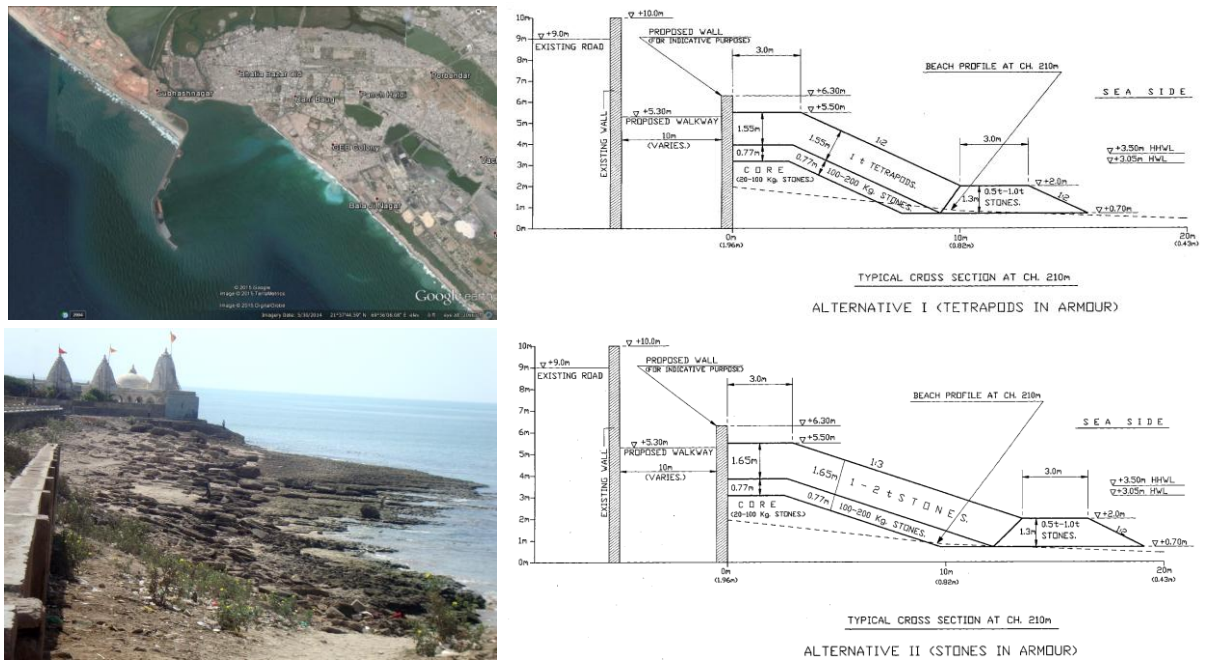
Fig. 2(a) Short Term Measure (Alt. III)



(b) Long Term Measure (Alt. d)

5255-DESIGN OF COASTAL PROTECTION WORKS AT PORBANDER, GUJARAT

The city of Porbander is located on west coast of India in Gujarat. For the last few years the coast of Porbander experiences severe damage due to heavy wave action during high water. The existing retaining wall and adjacent beach area is directly exposed to wave action and needs protection from wave action. Important premises such as Indreshwar temple, the Hindu Smashan, Gaushala, Muslim Kabristan, Old Light House and the District Library are situated at the erosion site. As such, about 690 m long coastline is proposed to be protected by construction of a seawall. The Project Authority requested CWPRS to undertake design of coastal protection works to protect the retaining wall and coastline adjacent to Indreshwar temple. It was decided that an additional retaining wall may be taken up by the Department of Salinity Control, Gujarat for providing the walkway infront of the existing retaining wall and the coastal protection works will be suggested by CWPRS. Accordingly, the design of seawall was suggested with two alternative cross-sections ie. one with tetrapods and another with stones in the armour layer. The design of cross-sections consists of 1 t tetrapods or 1 to 2 t stones in the armour layer to protect retaining wall and the adjacent beach at Chopati and at Indreshwar Temple near Kharvavad at Porbander, Gujarat. The sections were designed to withstand the breaking waves at the respective bed level.

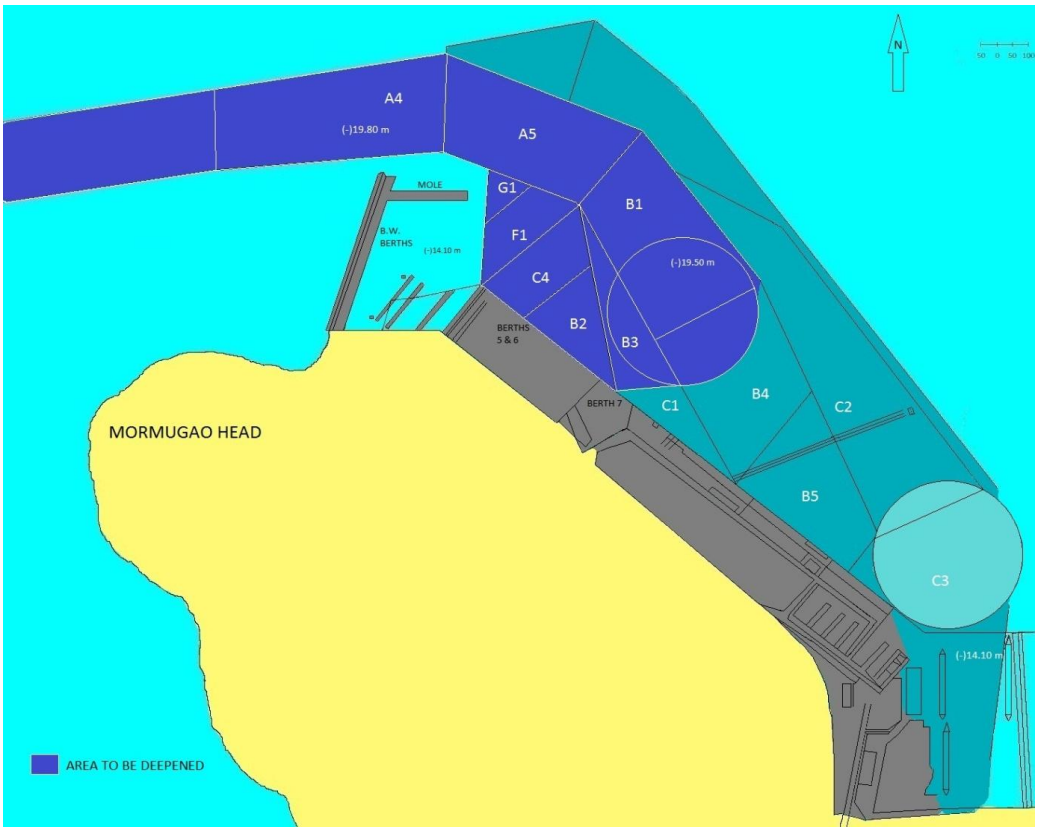


Coastal protection works at Porbander, Gujarat

5259-STUDIES FOR HYDRODYNAMICS AND SILTATION FOR DEEPENING OF APPROACH CHANNEL AT MORMUGAO PORT, MORMUGAO

The Mormugao port, one of the major ports, is located at the entrance of Zuari estuary on the west coast of India. The existing 250m wide approach channel is dredged to a depth of (-) 14.4m and harbor area and turning circle to a depth of (-) 14.1m for catering to 60,000 DWT size ships. Mormugao Port Trust has now proposed to deepen the existing approach channel for catering to the cape sized ships, to a depth of (-) 19.8m with an extended length of 3.5 km and harbor areas to (-) 19.5m involving an additional capital dredging of about 14.0 Mm^3. The present disposal grounds are located north of approach channel at a contour of -14.2m. For the deepening proposal of approach channel at Mormugao port, the studies at CWPRS were undertaken for; (i) assessment of annual maintenance dredging and, (ii) to suggest suitable disposal grounds. In the present study, 2-Dimensional hydrodynamic model MIKE 21 HD, near shore spectral wave model MIKE 21 NSW and mud transport Model, MIKE 21 MT, have been used to simulate the flow field and sediment transport in the existing and the proposed scenario under prevailing tidal and wave conditions.

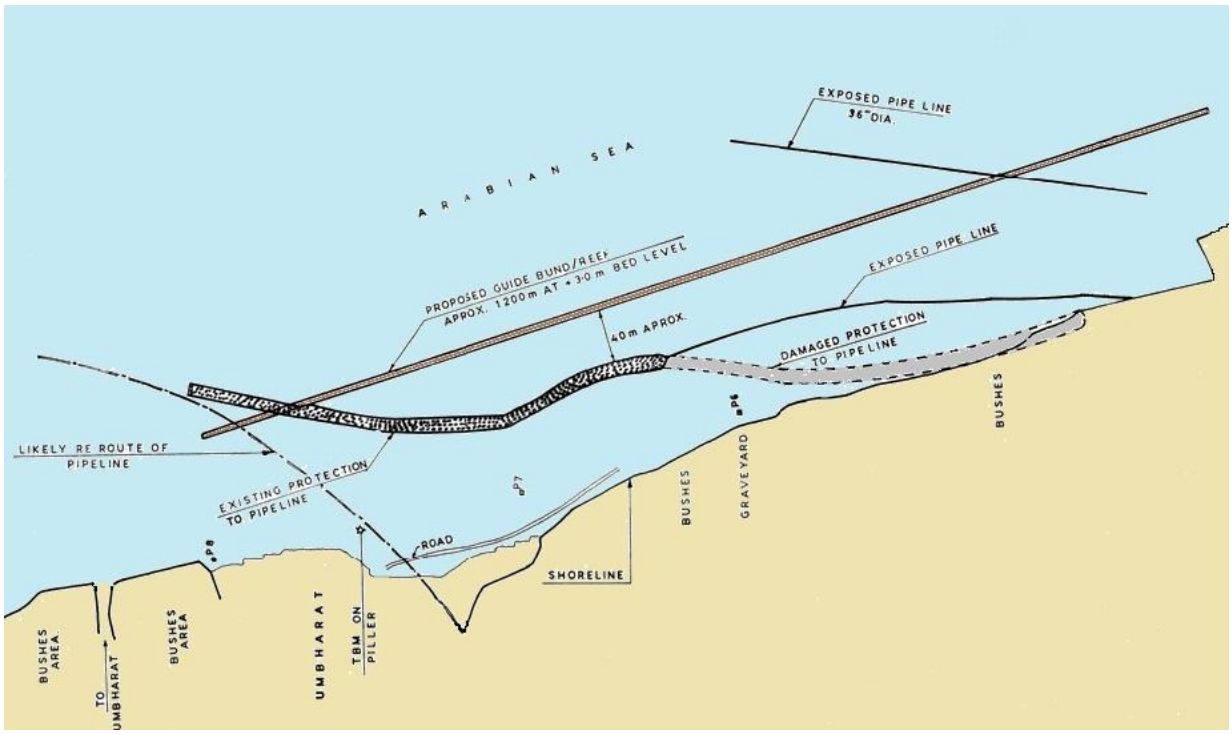
The main sediment transport mechanism in the Mormugao Port area is due to the deposition of the suspended sediments in the deepened areas. The bed material in the approach channel and harbor area is mostly of soft-silty-clayey nature. On the basis of the analysis of available water sample data collected during 1970s, the average sediment concentration has been considered as 0.040 ppt during the monsoon season and 0.012 ppt during the nonmonsoon season in the port and channel areas. The mathematical model was calibrated using the prototype velocity data collected in the approach channel and port region in 1967 during the stage-1 development and the previous dredging records of the Mormugao port. On the basis of the mathematical model studies conducted for the deepening proposal at Mormugao port, the total annual maintenance dredging quantity is predicted to be about 6.0 Million cum against the 3.0 Mcum at present. More than 90% of the siltation would place during the four months of the southwest monsoon season. The total dredging would be almost equal for the channel and harbor areas. The disposal grounds for the proposed deepening proposal are recommended to be located in an area of 2.0 km x 2.0 km at (-) 27.0m contour north of approach channel.



Layout plan showing proposed deepened areas in the Mormugao port

5260-MATHEMATICAL MODEL STUDIES FOR ASSESSMENT OF SHORELINE CHANGES FOR SBTH PIPELINE AT UMBRHAT BEACH, HAZIRA, GUJARAT

Mathematical model studies carried out at CWPRS for assess shoreline changes to examine the adequacy of the proposed layout for protection of pipeline. The natural gas produced by ONGC in the South Basin Field is transported to Hazira Terminal through two trunk pipelines viz., 36" and 42" diameter gas pipelines. Both pipelines have shore approaches at Umbrhat. The pipeline was laid parallel to the coastline over the beach and extended in the sea towards the offshore region. Earlier, this pipeline was buried inside the beach at the Umbrhat. Over a period of time the pipeline was exposed due to the scouring at the base caused by high wave action. In this regard, Chief Engineer (E) ONGC sought advice of CWPRS for the protection to the pipeline from the wave action. Mathematical model studies were carried out for prediction of shoreline changes due to the constriction of coastal protection works. The studies for shoreline changes indicated that Net transport in a year is of the order of 0.34 million cum and is towards north. The shoreline changes simulated for the proposed layout indicate that due to the construction of the offshore breakwater, accretion would take place on southern side of breakwater and erosion on northern side of breakwater. After 1 year the maximum cross-shore accretion would be about 43m and erosion on northern side by 32m. The profile changes simulated indicated that without offshore breakwater, maximum erosion would take place near pipe line by 0.6 m and with offshore breakwater, maximum erosion would take place near pipe line by 0.2 m and accretion of 2.5m would take place near pipe line. Construction of the offshore breakwater of length 1.2 km in 2 m depth would help in preventing erosion in the vicinity of the pipeline.

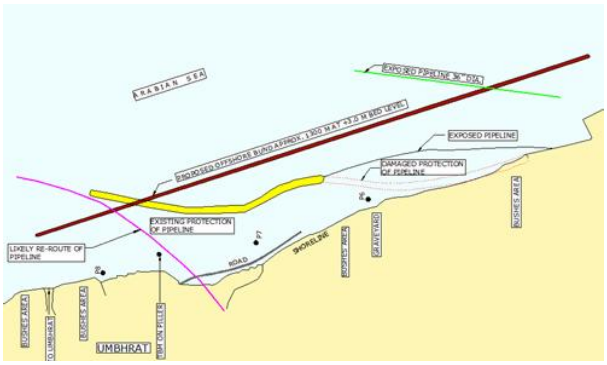


Layout plan of for the protection to pipeline

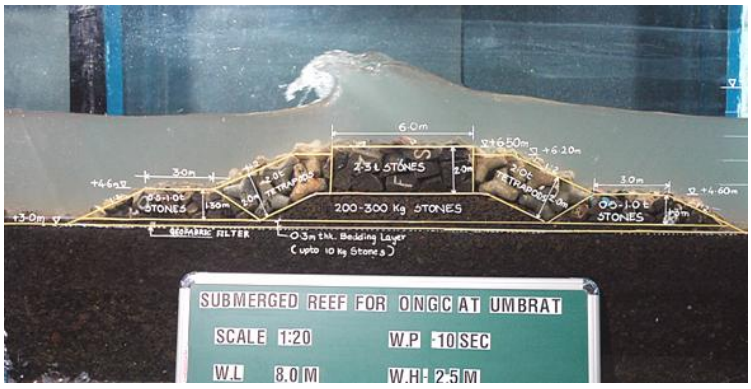
5261-DESIGN OF COASTAL PROTECTION MEASURES FOR THE EXPOSED ONGC PIPELINE AT UMBHRAT, HAZIRA, GUJARAT

M/s.Oil and Natural Gas Corporation Ltd. (ONGC) have laid South Basin Hazira Trunk (SBHT) Gas pipeline (42'' dia.) from Mumbai High to Hazira during 1994-1995. The pipeline was laid parallel to the coastline and protruding in the sea towards the offshore region. The pipeline has exposed due to the wave action and scouring at the base. The coast at Umbhrat faces higher waves causing scouring & erosion of the beach during monsoon period. ONGC proposed to provide a long term protection to the exposed 42'' ONGC pipeline. It was also decided to provide protection to the existing partially exposed 36'' ONGC pipeline which is located on the northern side of the 42'' pipeline. The ONGC has also considered the proposal of re-routing of the 42'' pipeline. The scope of the studies includes mathematical model studies for shoreline changes, and wave flume studies for the design of coastal protection works. Based on studies, the recommended layout consists of 1300 m long offshore bund placed at +3.0 m bed level, which is about 40 m apart from the existing 42'' pipeline on offshore side. The proposed offshore bund provides protection against the higher waves to the 42'' and 36'' pipeline as well as proposed re-reroute pipeline & to the eroding coast at Umbhrat.

The desk and wave flume studies are carried out for the design of cross-section of bund at +3.0 m bed level. Three alternative cross-sections of offshore bund have been evolved. Alternative-I consists of 2 t tetrapods in the armour placed on 1:2 slope with concrete cubes on the crest. Alternative-II consists of 2 t tetrapods in the armour placed on 1:2 slope with 2 to 3 t stones on the crest and Alternative-III consists of 3 to 4 t stones in the armour placed on 1:2 slope as well as on the crest. The hydraulic stability of the bund's cross-sections were assessed by conducting wave flume tests & found stable against the incident wave height upto 2.5 m.



Layout of offshore bund



Wave flume test for offshore bund

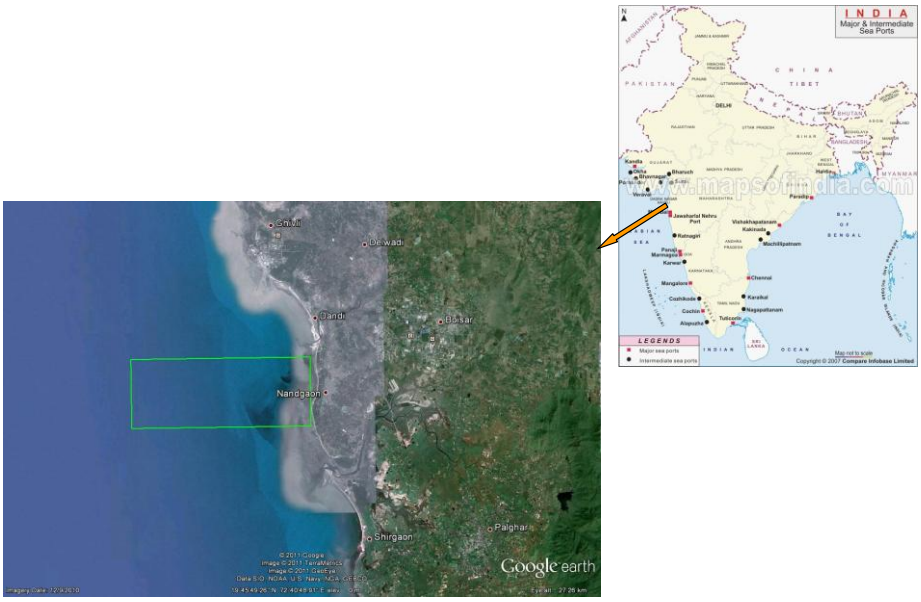
5265-MATHEMATICAL MODEL STUDIES FOR WAVE TRANQUILITY FOR THE PROPOSED DEVELOPMENT OF PORT FACILITIES AT NANDGAON, MAHARASHTRA

Maharashtra Maritime Board , Mumbai and JSW Infrastructure Ltd (JSWIL) have a proposal for development of all weather captive port at village Nandgaon, Tal- Palghar, Dist-Thane, situated on the West Coast of India at Longitude 72 ^{0} 41′ E and Latitude 19 ^{0} 46 ′ N (Fig.1). Location of proposed port is about 100 km north of Mumbai and south of the Tarapur Nuclear plant.

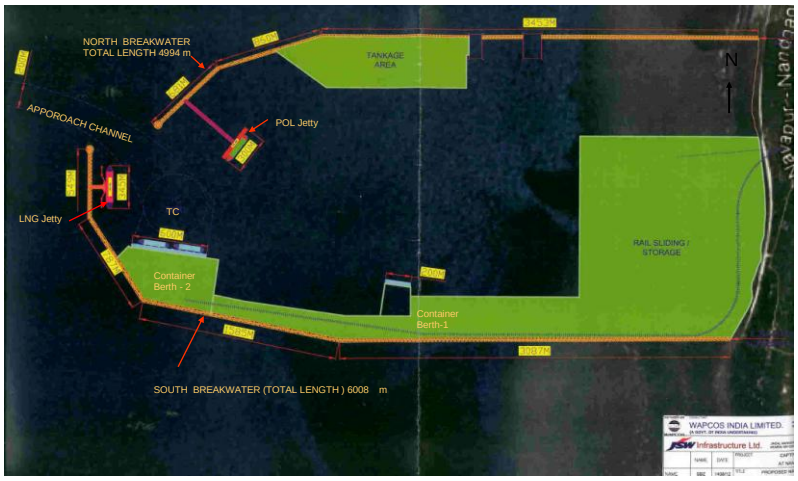
The mathematical model studies for wave tranquility were undertaken by CWPRS for two different layouts.The studies were carried out to examine the wave tranquility near the various berths and approach channel in the proposed two port layouts. The mathematical model studies were carried out in two stages. In the first deep water wave condition were transformed to the nearshore wave conditions and in the second the layout of the port was examined using the transformed wave condition for the wave tranquility to assess the maximum number of days of operation in a year at the berths. The layouts for the proposed port were provided by Maharashtra Maritime Board.

The Layout 1 (Fig 2) consists of northern breakwater with total length of 4994 m and southern breakwater of total length of 6008 m with 200m wide approach channel. The Layout 2 (Fig 3) consists of 4230 m northern breakwater and 6345 m south breakwater with 250 m wide approach channel.

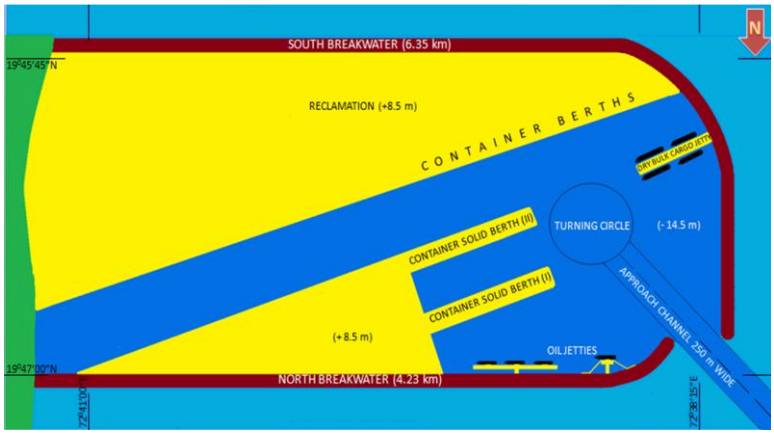
The studies indicated that the specified wave tranquility can be achieved for both the layouts for almost entire year of incident waves from NW, West, WSW and SW directions. Thus it was confirmed through model studies that the wave heights near the proposed berths, jetties, turning circle and approach channel would be within the permissible limit round the year. Though both layouts described above provide adequate protection to the proposed harbour from the wave tranquility point of view, the feasible layout will be further confirmed based on the findings of hydrodynamic and sediment transport model studies.



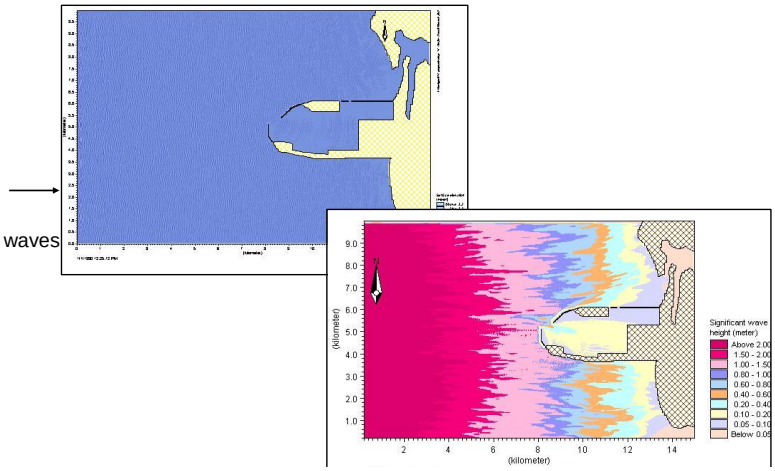
Location of proposed Nandgaon Port



Proposed Layout - 1



Proposed Layout - 2

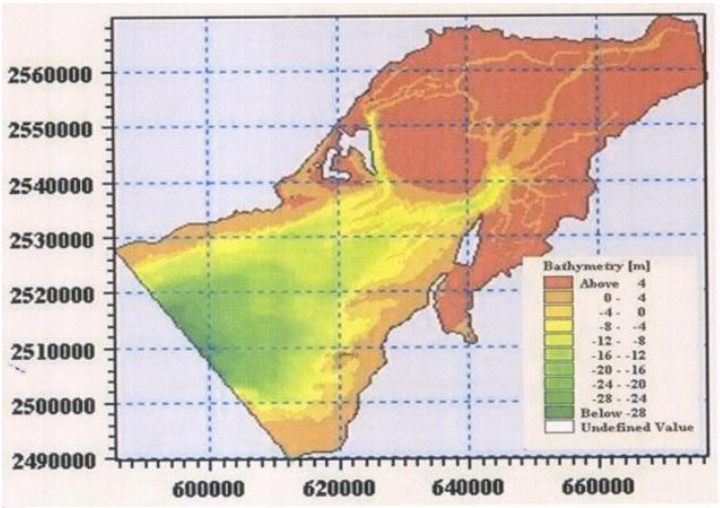


Typical wave propagation and wave height contour plot for layout -1
Incident wave direction /wave height –west /3.5 m

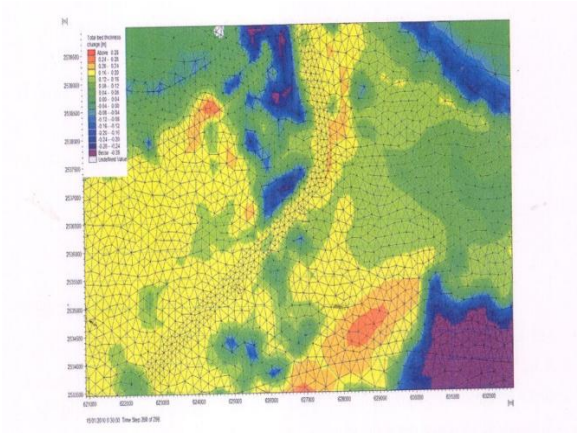
5270-MATHEMATICAL MODEL STUDIES FOR SHIFTING OF NAVIGATIONAL CHANNEL AT KANDLA PORT

The Kandla Port, a major port on the west coast of India, is located at the head of the Gulf of Kutch, in the state of Gujarat. The port is of strategic importance and is the nearest Indian port from the Middle East and Europe. It is also well connected to the hinterland through rail and road network. Though, the port is in operation since fifty years or more, it is handling only the dry and the liquid cargo. The region is tide dominated and the wave disturbance in the approaches to Kandla Port is not significant. Generally, it is observed that the morphology in the approach to Kandla Port is very dynamic in nature with frequent shifting of shoals and it was often required for the Kandla Port to shift and suitably locate the approach channel. The present port facilities are located inside the Kandla Creek, which has natural depths up to (-) 20.0 m below Chart Datum (CD) in some parts and is also well protected from waves. The major bottleneck in the development of the port has been the shallow approaches from the Gulf of Kutch. The present navigation channel known as Sogal Channel is about 16 km. Due to the orientation of the Kandla creek, the channel has a curvature between Buoy no 8 and 8A, where the flow direction changes before entering the creek. The Kandla Port is continuously making efforts to cater to higher draft vessels by dredging on a daily basis with maintenance dredging of the order of 7 – 8 Million m^3 per annum. At present, KPT is able to maintain (-) 8.5 depth all along the channel.

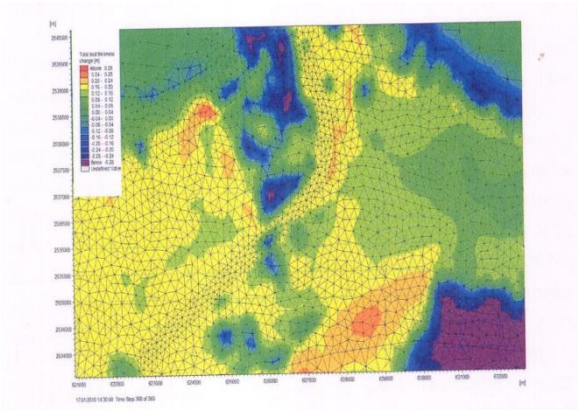
In the recent years, though continuous efforts are made to maintain the depth along the western bank of the channel between Buoy no.8 and Buoy no 10 hardly they are achieved. Hence, Kandla port proposed to shift the navigational channel. Accordingly, two dimensional Mathematical model MKE 21 HD software is used to set up of the Hydrodynamic flow model of to Gulf of kuttch including Kandla Hansthal creek system with available bathymetry to understand flow dynamic in the region with existing channel and by shifting the channel by 50 m towards eastern bank between Buoy no.8 and Buoy no 10 and subsequently, a sediment transport model to assess the rate of siltation. The study result has indicated that shifting the channel by 50 m towards the eastern edge, the overall flow condition in the region will remain unchanged and hence, the change in siltation pattran.



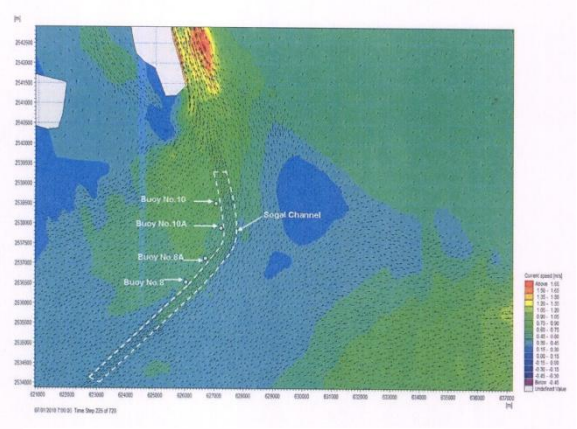
Bathymetry of Gulf Kutch and Kandla-Hasthal creek system



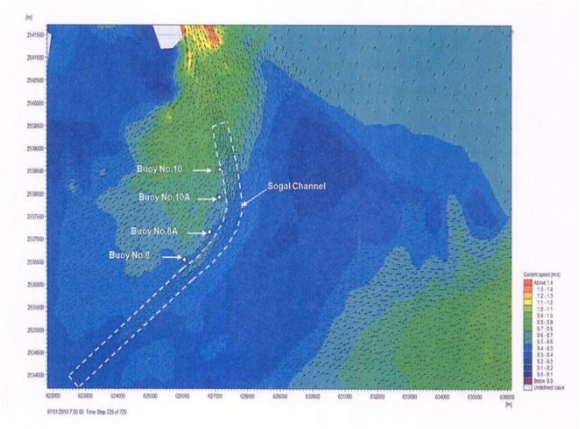
Total bed thickness change in existing navigational channel



Total bed thickness change after shifting navigational channel



Flood flow in exting channel



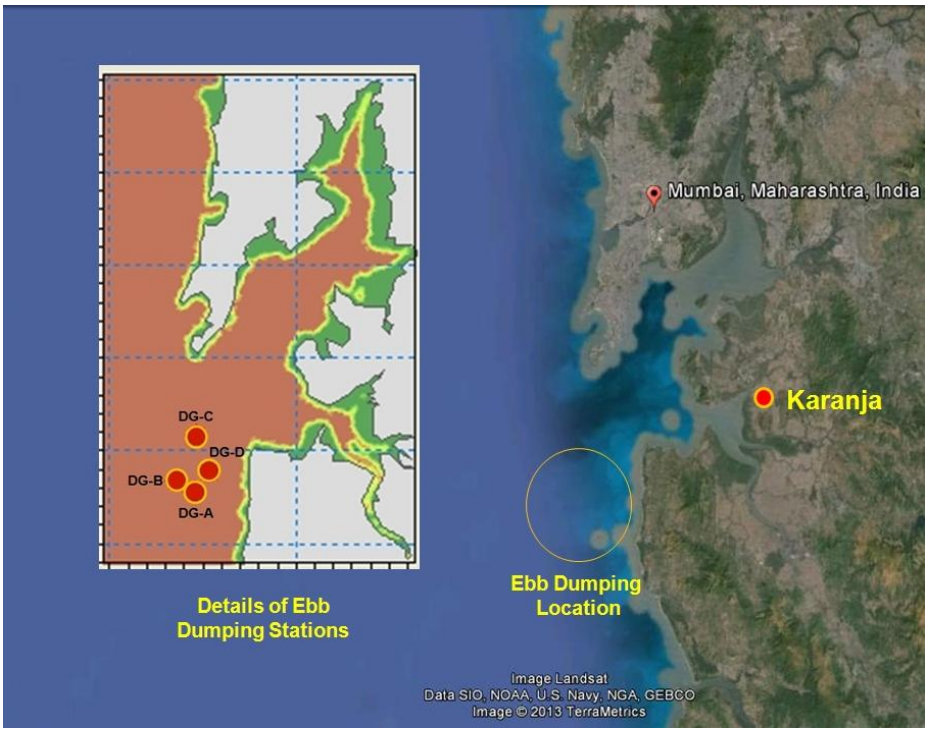
Flood flow after shifting the channel

5271-MATHEMATICAL MODEL STUDIES FOR ALTERNATE EBB DUMPING SITE FOR DISPOSAL OF DREDGED MATERIAL FROM PROPOSED MULTIPURPOSE TERMINAL AT KARANJA CREEK, NAVI MUMBAI

M/S Karanja Terminal and Logistics Pvt. Ltd. (KTLPL) is developing a multipurpose terminal at Karanja creek, Navi Mumbai. In this regard a mathematical model study was undertaken for tidal hydrodynamics and sediment transport by Central Water and Power Research Station (CWPRS) earlier, on behalf Water and Power Consultancy Services Ltd. (WAPCOS), including dredged material disposal and dispersion studies at designated dumping grounds in the sea off Mumbai. The dredging needs to be done to facilitate depth for ship navigation in the creek while constructing a new terminal at Karanja. Dredged material generation is proposed to be dumped at nearby feasible and suitable location from economical and technical point of view. These mathematical model studies for alternate ebb dumping site had been referred by M/s WAPCOS on behalf of KTLPL. The location of Ebb Dumping Ground as proposed is shown in the figure.

The study was done using MIKE 21 Hydrodynamics (HD) Mud transport (Mt) module which are run in coupled mode. The dumping is simulated as a source in the model at the desired location. There are four dumping locations on southern side of the creek. The names are given to them as Dumping Ground DG-A, DG-B, DG-C and DG-D respectively and effects of dumping at these locations have been analyzed systematically at points 'Point-1', 2 and 3 which are surrounding to them and at 'Revadanda Creek' which is far southern to Karanja. The graphs have been plotted for all these locations as far as deposition and spread of material is concern.

From detailed analysis and interpretations of results, it is concluded that the dumping is to be carried out at ebb phase of tide especially 1 hour after the High Water and should be stopped one hour before the low water. Among the four locations, Ebb Dumping location DG-B (Lat. 18^0 46.20' and Long.72^0 47.5') is found to be more suitable compared to other dumping locations if considered the time required to restore the ambient conditions after the dumping ceases would be about 15 to 20 days.



Dumping Locations for Ebb Dumping Ground at Karanja, Navi Mumbai

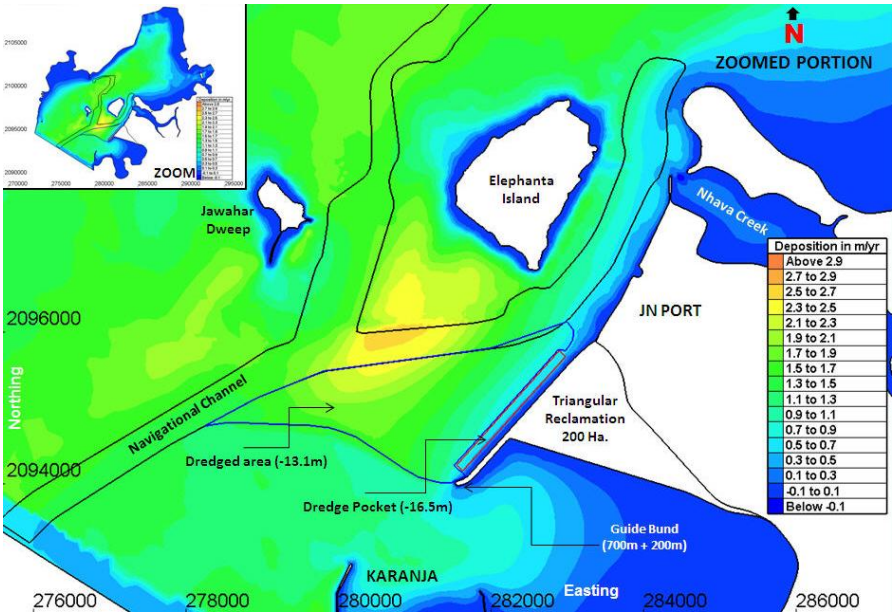
5272-MATHEMATICAL MODEL STUDIES FOR THE DEVELOPMENT OF FOURTH CONTAINER TERMINAL AT JAWAHARLAL NEHRU PORT, MUMBAI

The Jawaharlal Nehru Port (JNP) is a major port of India and is situated in Thane creek with its location at latitude 18° 56′ 43″ N and longitude 72° 56′ 24″ E. It is a container port and being well inside from wide entrance to Arabian sea, it is protected against the furry of ocean waves. The JNP earlier have a proposal to develop a 2 km long container terminal in two phases with 200 Ha of reclamation on leeside along with chemical and LNG berths to be developed in different phases . CWPRS had submitted report in the year 2006 based on the studies carried out on physical and mathematical models for the layout proposed earlier. The port, considering the present trend of developing mega terminal and to improve upon operational efficiency, now desires to carry out the development of 2 km long container terminal in one stretch along with 200 ha. of reclamation on the lee side of the terminal.

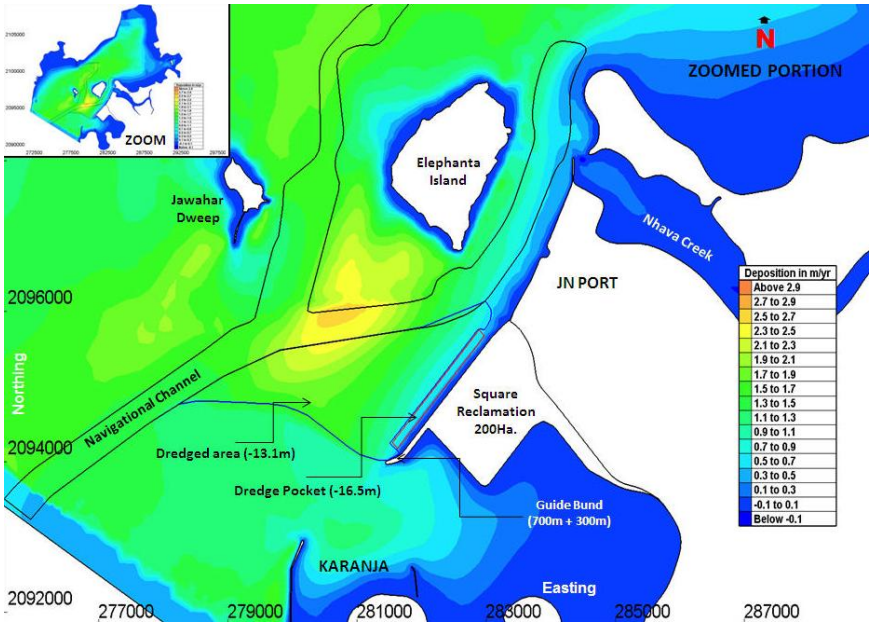
The layout for the proposal of 2 km long Fourth Container Terminal (FCT) prepared by M/s. Tata Consulting Engineers (TCE) with berth pocket at 16 m and dredged area at 13.1 m below CD for JNP (Layout- I) was studied on a physical model of Mumbai Port at CWPRS. This layout being not suitable from tidal hydrodynamic conditions all along 2 km length, modified proposal was submitted by JNP as Layout-II to assess its suitability from hydrodynamic consideration by mathematical model studies. The Layout-II also has 2 km long berth in one stretch in line with existing BPCL berth with a gap of 250 m and 200 ha. of reclamation in rectangular shape on its leeside. The studies carried out based on oceanographic data available at CWPRS reveal that the layout is suitable for the flow conditions along the berth up to a length of 1.6 km from the northern end of the container terminal. Also southernmost end of the reclamation in Uran mud flat area being crossing the port limit of JNP, JNP further modified the layout-II in consultation with CWPRS as Layout-III.

The proposal for the development of FCT as Layout-III was evolved by keeping a sufficient distance of 250m between berth faces of existing BPCL berth and northern end of container terminal for easy movement of ships not only at BPCL but also at FCT along with two alternatives viz. triangular/square shape of reclamation having area of 200 ha on leeside. The Layout-III studied on mathematical model for both alternatives revealed that flow conditions in front of container up to length of 1850m from the northern end of the container terminal are suitable irrespective of phase of tide. In view of undesirable flow conditions at the southern most end of terminal, the length of reclamation bund on leeside of the terminal was extended in stages of 100m, 200 m and 300 m and optimal length of bund extension was evolved to achieve desirable flow condition along the entire length of 2 km container terminal for both triangular/square shape of reclamations. The studies carried out with 200m / 300m extension of the guide bunds reveal that 200m extension for triangular shape, while 300m extension for square shape of reclamation achieves desirable flow condition at the berth. The studies carried out with triangular shape of reclamation may not have significant impact on the adjacent area at Karanja harbour.

The estimation of likely rate of siltation at the proposed berth pocket and dredged area in front of container terminal was carried out by coupling the hydrodynamic model for Layout-III with silt module. The silt module is initially calibrated for the prevailing rate of siltation in the navigation channel at JNP based on the dredging data supplied by project Authority for year 2009-10. The silt model gives reasonably good comparison of siltation observed in model with the prototype data for the existing bathymetry. The likely rate of deposition for the layout-III for both the alternatives (triangular / square) in association with 200m / 300m extension of guide bund revealed that the rate of siltation varies between 5.6 Million cum/annum and 5.81 Million cum/annum. The layout III studied with the help of mathematical model revealed that the proposal not only provides desirable hydrodynamic conditions all along the 2 km length of container terminal but also flow conditions at the existing berthing facilities at JNP will not get hampered. The siltation rates estimated from model in dredged area for both the alternatives of layout-III are shown in following Figure.



Siltation pattern for triangular reclamation at FCT



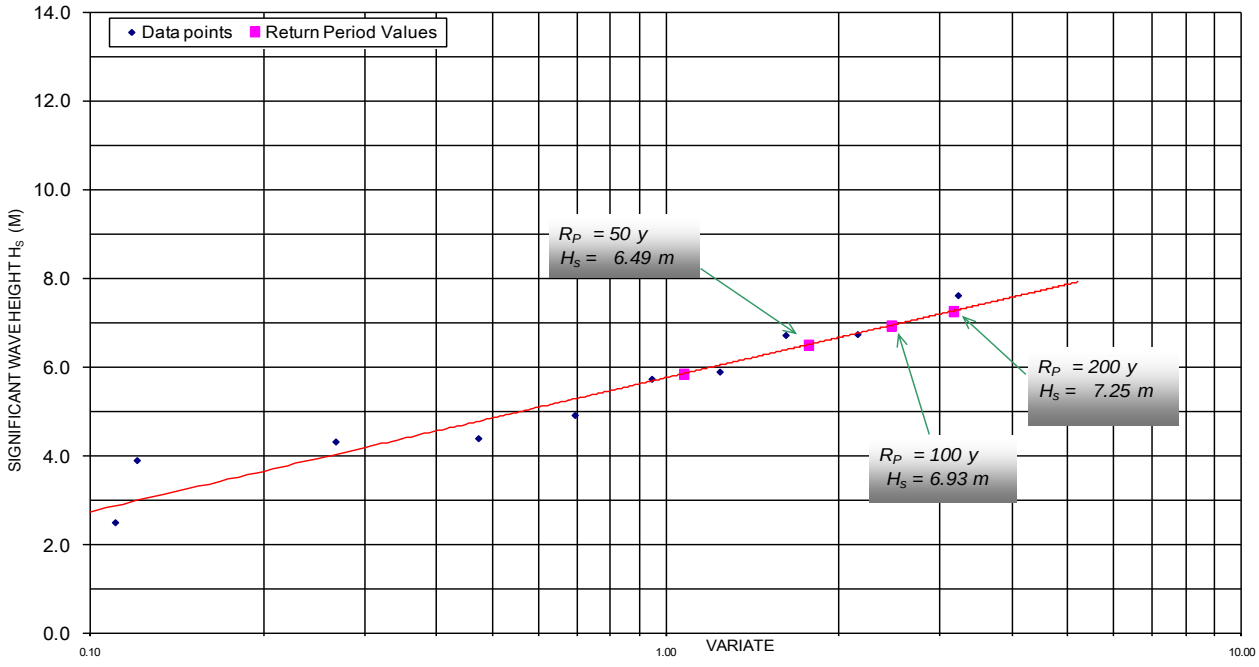
Siltation pattern for square reclamation at FCT

5277-STORM WAVE HINDCASTING STUDIES FOR THE PROPOSED DEVELOPMENT OF OUTER HARBOUR AT V.O. CHIDAMBARANAR, PORT TUTICORIN, TAMILNADU

Tuticorin is located on the shores of Gulf of Mannar at the Southern tip of India near Kanyakumari in Tamilnadu state (Lat.8º 48' N & Long 78º 11' E). Tuticorin port is an artificial harbour formed with a breakwater system having two long parallel breakwater nearly 4000 m each and 1275 m apart encompassing 400 ha of water area.. Studies for storm wave analysis were carried out for the design wave height to determine breakwaters design at Tuticorin port considering the past storm data of 370 cyclones, which are significant for Tuticorin coast, occurred during the period of 120 years from 1891 to 2010.

The determination of extreme waves carried out based on the statistical analysis of long-term measurements. Since the long-term measurements of waves, which occur during the storm (cyclonic) conditions, are seldom available, the extreme value analysis for the waves is carried out using hindcast storm waves data (predicted values using past storm data). The extreme value analysis of these hindcast data provides the waves of various return periods required for the design of coastal structures and determination of safe-grade elevation.. The hindcast data of the wave heights were subjected to extreme value analysis using Gumbel (Type-I), Weibull and Log–Normal distributions to determine the storm wave values for different return periods.

The extreme value analysis of the hindcast storm data indicated a storm wave value of 8.6 m, 6.5 m, and 5.6 m for 200-years, 100-years and 50-year return period respectively for the Tuticorin coast. These values would be useful for design wave height for breakwater design at Tuticorin Port.



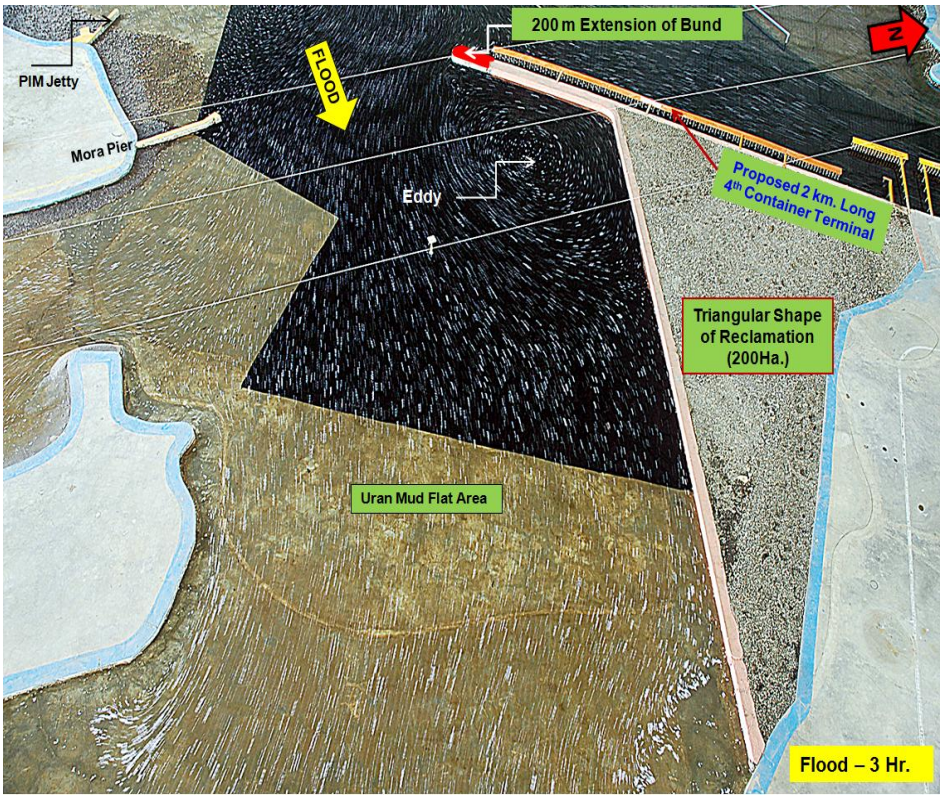
Hindcast wave data of Tuticorin coast on Gumbel distribution (at 40m depth)

5278-PHYSICAL HYDRAULIC MODEL STUDIES FOR THE MODIFIED LAYOUT OF FOURTH CONTAINER TERMINAL AT JAWAHARLAL NEHRU PORT, MUMBAI

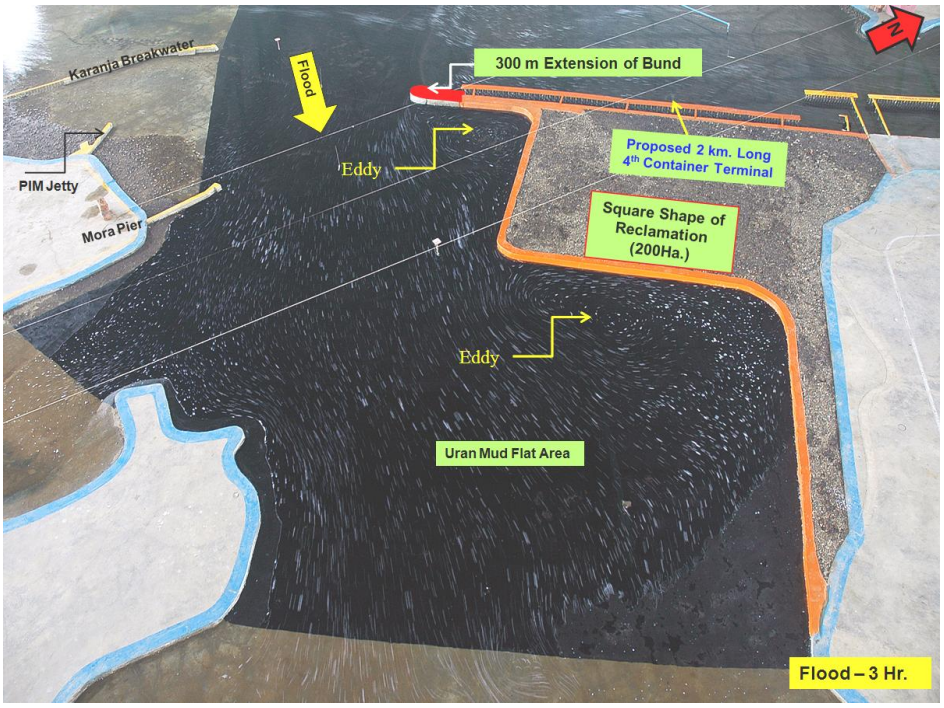
The Jawaharlal Nehru Port (JNP) is a major container port of India and is situated in Thane creek in the state of Maharashtra. The location of port is at latitude 18° 56′ 43″ N and longitude 72° 56′ 24″ E. The port facilities being well inside from the wide entrance to Arabian sea, present waterfront facilities are protected against the furry of ocean waves. The JNP presently have a 2 km long berthing facility and in the past have a proposal to develop additional 2 km long container terminal in two phases with 200 Ha of reclamation on leeside along with chemical and LNG berths to be developed in different phases. CWPRS for the above expansion plan of JNP had carried out studies on physical and mathematical models and submitted the report in the year 2006. The port, considering the present trend of developing mega terminal and to improve upon operational efficiency, now desires to carry out the development of 2 km long container terminal in one stretch along with 200 ha. of reclamation on the lee side of the terminal.

The layouts prepared by M/s. Tata Consulting Engineers (TCE) for Fourth Container Terminal (FCT) on behalf of JNP have a 2km long berth face in one stretch with area in front of terminal and berth pocket dredged to 13.1 m and 16.5 m below CD respectively as well as 200 ha of reclamation on its leeside. The JNP desires to have entire 2 km of berth face of terminal aligned properly with the flow field from tidal hydrodynamic consideration. The layout-I and layout-II for FCT studied at CWPRS has been found to be not suitable either from hydrodynamic considerations or reclamation area crossing the port limit of JNP. As such proposal for the development of FCT as Layout-III was evolved by JNP in consultation with CWPRS. This modified proposal for the development of FCT (layout-III) consist of 200 ha of reclamation on leeside of the terminal and berth length of 2 km with dredging up to 13.1 m and 16.5 m in front of terminal and at berth respectively. This layout also consists of two alternative shapes of reclamation viz. triangular/square. The Layout-III studied initially on mathematical model for both alternatives revealed that the length of guide bund on leeside of the terminal with its extension by 200m for triangular shape, while 300m for square shape of reclamation achieves desirable flow condition at the berth. The Layout-III of FCT studied on mathematical model with two alternatives consisting of triangular/square shape of reclamations which are found suitable were also studied on physical tidal model of Mumbai port having scale of 1:400(H); 1:80(V). The tides were generated with help of automatic tide generator to reconfirm these results or suggest modifications if any from tidal hydrodynamic considerations.

The tide generated on physical model compares well with proto tide at Apollo Bundar. The Layout-III studied on physical model with two reclamation shapes viz. triangular & square on leeside of terminal reveal that in order to have proper flow conditions near the berth face at northernmost end of terminal, existing solid approach bund used to connect landing jetty should be replaced by approach trestle on piles. The studies carried out for both the alternatives reveal that flow field at the northernmost end and central portion of the terminal is well aligned with berth irrespective of phase of tide. However due to significant variation in incident angle of current during flood tide at southernmost end of FCT, the guide bund needs to be extended by 200m/ 300m in length along with a dredge circle of about 200 m Dia. deepened to 16.5 m below CD at southernmost end to achieve desirable flow condition all along 2 km length of terminal. The studies carried out also reveal that triangular shape of reclamation having extension of guide bund by 200 m and square shape of reclamation with 300 m achieves desired flow condition all along 2 km length of berth. Studies also reveal that formation of eddy south of southern-most end of the terminal/leeside of guide bund etc is governed not only by length and orientation of the guide bund but also depends on the shape of the reclamation proposed behind the fourth container terminal and is shown in figure. The triangular shape of reclamation with 200 m extension of guide bund achieves favourable hydrodynamic condition all along 2 km length of the berth as well as its impact on existing nearby marine facilities is insignificant.



Flow pattern for triangular reclamation at FCT



Flow pattern for square reclamation at FCT

FOUNDATION & STRUCTURES

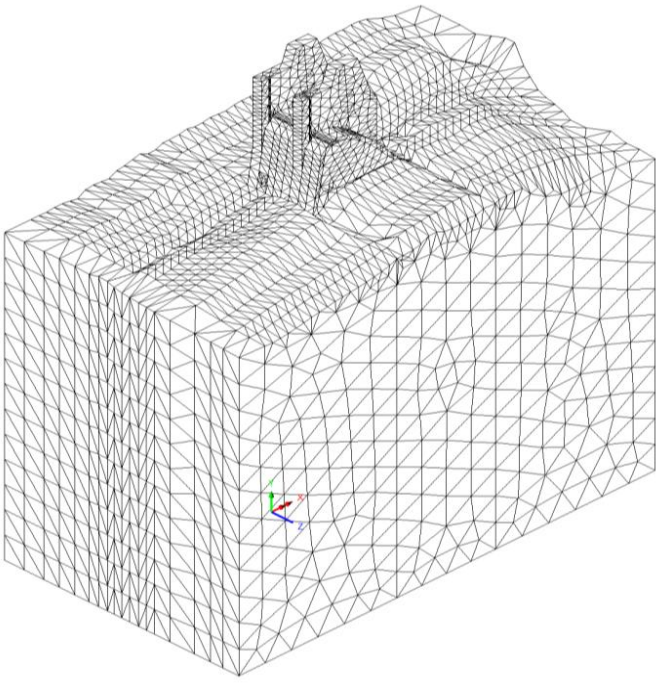
5170-TEMPERATURE CONTROL STUDIES FOR BHAM DAM, MAHARASHTRA

Bham dam is proposed to be constructed across river Bham near village Kaluste, of Igatpuri taluka of Nashik district in the state of Maharashtra. The main components of the dam are a central concrete spillway, earthen embankments on either side of the spillway and divide walls. The central spillway is proposed to be constructed using M-15 grade concrete mix at core with glacis cover of M- 20 grade concrete. The cementitious contents of these two concrete mixes being 322 kg/m^3 and 400 kg/m^3 respectively. The estimated quantity of M-15 grade concrete is 305622 m^3 and that of M-20 grade concrete is 16888 m^3. Considering the high content of cement and mass volume of concrete, it was desired by the project authorities to estimate suitable placement temperature for avoiding thermal cracking of concrete and the studies were entrusted to Central water & Power Research Station. Considering the large volume of M-15 grade concrete as compared to the volume of M-20 grade concrete, the studies were restricted to M-15 grade concrete only. The report describes the findings of studies and suggestions.

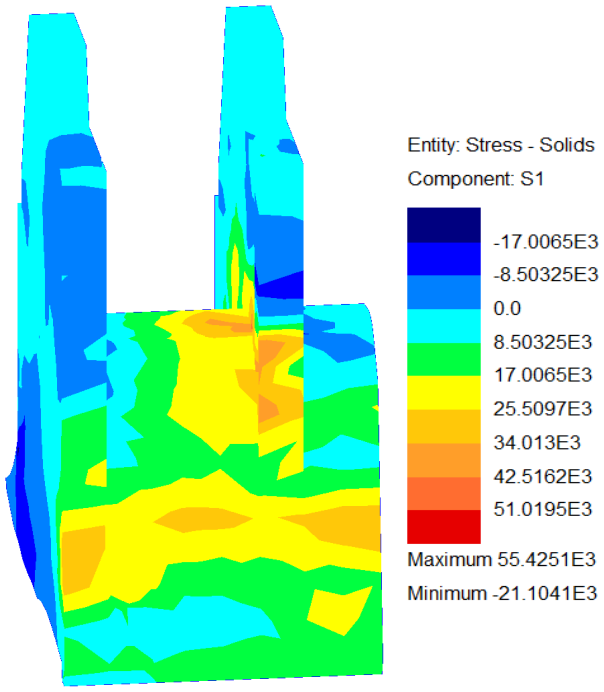
The block width considered for computations is 15 m and average annual air temperature of the dam site is taken as 27.4^{0}C. The adiabatic temperature rise of the concrete mix is high and also the rate of rise. This would require excessive cooling to meet the construction schedule. Considering economic aspect for the concreting of the Bham dam, the conventional cooling arrangements like adding ice, pre-cooling of aggregates by inundation method are avoided as far as possible. Measures are suggested for achieving the suitable placement temperature. The placement temperature of concrete at batching plant is derived as between 260C - 28^{0}C. These measures include, minimum time between mixing and placing of concrete, limiting lift height to 1 m maximum, lift interval 120 hours, casting of alternate block, cooling of aggregates by spraying water, continuous curing of concrete, use of chilled water for mixing concrete etc.

5179-3D STRESS ANALYSIS BY FEM OF BAY AREA OF SPILLWAY GATE NO.1, TELENGIRI DAM, JEYPORE, ODISHA

Telengiri dam is proposed to be constructed across Telengiri river, a tributary of Indravati river near Ranigada village, under Upper Kolab Project, Jeypore in Odisha. The dam consists of 1192 m long and 43 m high earthen dam along with 48.5 m high concrete spillway comprising 4 blocks of 15.5 m length each. The purpose of constructing the dam is to create storage reservoir to provide water for irrigation to more than 1400 Hectares of land in Borigumma block. The present study deals with 3D stress analysis of 48.5 m high spillway Block Nos. 1-2 to evaluate the tensile stresses and displacements developed at critical locations in the body of the spillway blocks under four static load combinations and three static plus earthquake load combinations in accordance with IS:6512-1984. Material properties based on different grades of concrete have been incorporated in the analysis. The horizontal seismic coefficients under earthquake load combinations D,E and G have been evaluated based on revised BIS code IS: 1893-2002 (Part 1) and analysis has been carried out as per criteria mentioned in IS:1893-1984. The bay area of Spillway gate No.1 has been discretized into 40146 four noded linear tetrahedral solid elements using 16533 nodes by including all the details of openings such as Seepage gallery, Construction sluice, gate slots, shear key and exposed foundation rock strata using LUSAS general purpose Finite Element software version14.3. Under static load combinations B,C and F, the maximum tensile stress, of the order of 2.289E04 kg/m2 per unit length, has been found to be developed near the crest of the spillway. Under Earthquake load combinations including static loads, the maximum tensile stress of the order of 5.5425E04 kg/m2 per unit length, has been found to have developed near the crest of spillway and at upstream face under load combination G. The maximum (tensile) and minimum (compressive) principal stresses developed in the bay area of spillway gate no.1 under various load combinations including displacements have been found to remain within permissible limits.



3D FEM of Bay area of Spillway Gate No.1 including Foundation

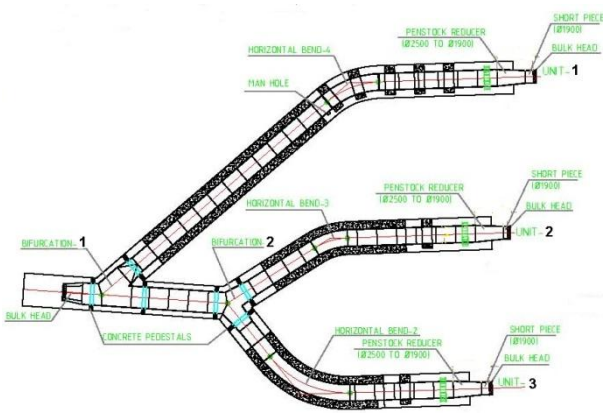


(+): Tension, (-): Compression

Maximum Principal Tensile stress Distribution in bay area of Spillway Gate No.1 under Load Combination G

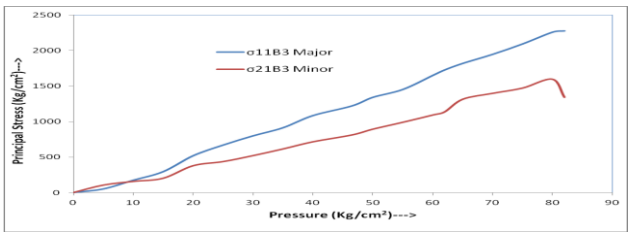
5186-STRAIN MEASUREMENT IN PENSTOCK BIFURCATIONS 1 & 2 DURING PROTOTYPE /IN-SITU HYDROSTATIC TEST, TEESTA-III, H.E. PROJECT, SIKKIM

1200 MW Teesta-III underground H.E.Power House is under construction in Mangan districts of Sikkim state. The project consists of 60 m high concrete faced rockfill dam under construction across Teesta river, an Intake structure, two De-Silting Chambers of size 17m width x 23m height x 320m length, one 13.8 km long horseshoe type 7.8m diameter Head Race Tunnel for conveying 175 cumec discharge, one 13m diameter orifice type 160m high Surge Shaft and two Pressure Shafts of varying diameter from 4m to 3.25m to 2.5 m. Each 48 mm thick steel lined Pressure Shafts of 3.25m diameter, bifurcates at two points for feeding water to three generating units. The pressure shafts including 4 bifurcations fabricated using Dillimax 690 PE steel having minimum yield strength 6829.76 - 7033.64 kg/cm^2 have a shell thickness varying from 40 to 48mm and 100mm thick sickle plates. The design pressure inclusive of 30% rock participation is 88.3 kg/cm^2. The design verification and structural safety assessment of penstock bifurcation 1 and 2 connected to three generating units has been carried out by conducting in-situ / prototype hydro static tests using strain gauge instrumentation technology. After studying report on stress analysis by FEM of bifurcations forwarded by Project Authority, fifteen critical locations in the probable high stress zones have been selected on the outer surface of each penstock bifurcation at which weldable uniaxial strain gauges have been installed in linear, biaxial and rosette configuraion. The principal stresses computed based on measured strains at selected important locations on bifurcation 1 & 2 have been observed to remain within allowable limits up to applied internal pressure of the order of 82 kg/cm^2.

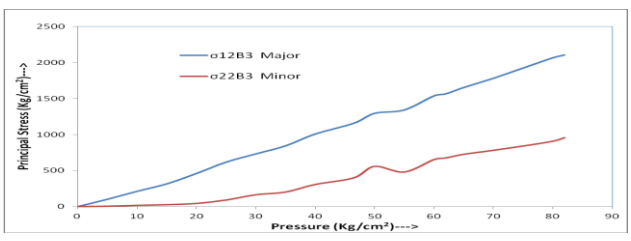


General view of Penstock bifurcations 1&2

Top view of Penstock bifurcations 1 & 2



Principal stress variation at a location in bifurcation-1



Principal stress variation at a location in bifurcation-2

5189-ASSESSMENT OF QUALITY OF COLGROUT MASONRY OF TARALI DAM, SATARA, MAHARASHTRA

Tarali dam is a colgrout masonry gravity dam being constructed across Tarali river, a right bank tributary of river Krishna in Satara district of Western Maharashtra. The height of the dam above lowest foundation is 73.4 m and the total length is 1096 m, out of which 75 m is across spillway portion and non overflow section is 1021m. The gross storage capacity of reservoir is 165.7098 hm^3; and live storage capacity is 165.4624 hm^3. Project authority requested CWPRS to conduct laboratory studies for determining compressive and split tensile strengths of 150 mm diameter extracted cores from colgrout masonry of Tarali Dam. Extracted cores of 150 mm diameter from two monoliths namely M-6 & M-9 have been supplied to CWPRS for evaluation of strength properties. Extracted cores were dressed to required size to determine their strength properties as per the standard practice/procedure mentioned for ordinary concrete specimens. Only 7 cores found suitable for compression testing have been tested for determination of compressive strength. The compressive strength computed from compression testing results of extracted cores varies from 96 kg/cm^2 to 270 kg/cm^2. Only 4 cores found suitable for split tension testing have been tested for determination of split tensile strength. The split tensile strength computed from split tension testing results of extracted cores varies from 11 kg/cm^2 to 16 kg/cm^2. The mass density of colgrouts masonry varies from 2.4 to 3.1 gm/cc (2.4 - 3.1 t/m^3). The percentage of mortar in colgrouts masonry samples computed from tested core specimen varies from 3.33 to 47.6.

Upstream view of Tarali Dam

Compression test under progress

Split Tension test under progress

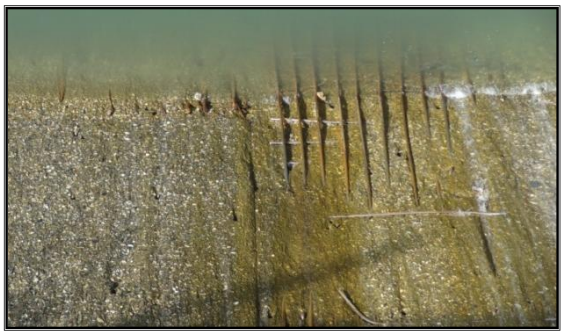
5199-STUDIES FOR REPAIRS TO SPILLWAY GLACIS AND SLOTTED ROLLER BUCKET OF ICHARI DAM, UJVNL, UTTARAKHAND

Ichari dam is a concrete gravity dam having height 59.25 m, length 155 m and a live storage capacity 5.11 million m^3. The scheme is built under Yamuna Hydroelectric Scheme Stage II and is a run-of-the-river scheme over Tons river with pondage required for peak power generation. The spillway has seven bays with radial gates. The crest profile of the dam is designed for the design discharge of 13500 cumecs. The energy dissipation arrangement consists of slotted roller bucket in all the spillway bays. The dam provides water to 240 MW capacity underground Chibro power houses. At the request of the project authority, the Ichari main dam and the associated structures of the dam were inspected for identifying repair procedures and repair materials. The damages observed during the site inspection were scouring of surface of spillway, pitting of surfaces of the teeth and cavities in roller bucket surface, exposing reinforcement.

Studies are conducted to identify suitable repair materials like primers for bonding, epoxy concrete for deep pot holes, micro concrete for resurfacing, epoxy mortar for shallow cavities, grouting system for crack filling etc. The studies includes determination of compressive strength, bond strength, penetrability, abrasion resistance, modulus of elasticity and any other specific test as per site conditions. The materials from different manufacturers were tested /evaluated in laboratory and also by casting panels on spillway portion at dam site for meeting the site specific requirements.

From the results of various tests, observations made on the mortar during mixing, casting, laboratory test and observations on the panels cast at site, the suggestions and recommendation for use of different materials etc. have been presented in the report.

View of the Ichari dam



Pitting and reinforcement Exposure

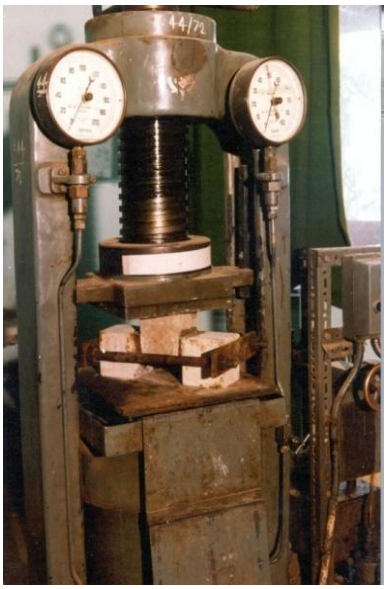
5202-STUDIES ON REPAIR MATERIALS BY M/S DIMPLE CHEMICALS & SERVICES PVT. LIMITED, PUNE FOR THEIR USE IN VARIOUS APPLICATIONS OF REHABILITATION OF HYDRAULIC STRUCTURES

M/s Dimple Chemical and Services Pvt. Ltd, (DCSPL), Pune, manufacturer of chemicals and cementitious materials which are in use for repairs and strengthening of masonry and concrete structures requested CWPRS for undertaking laboratory studies on supplied repair materials to evaluate their physical properties for assessing their suitability in carrying out repairs & rehabilitation of distressed hydraulic structures. As a part of testing program, studies on Poly Ironite Ceramic Cementitious (PICC) mortar and bonding agent have been conducted.

The PICC mortar has been evaluated for compressive strength, density, tensile strength, permeability (K) value and resistance to abrasion (loss in weight per unit area), whereas bonding agent comprising mixture of Kelox R 101 M and Kelox H 404 M have been evaluated for pot life, viscosity, bonding properties.

The most of the properties evaluated indicate that PICC mortar is suitable for repairing surface damages under dry condition in hydraulic structures. However, durability and long term performance must be evaluated through field application on trial basis before undertaking repair and rehabilitation of surfaces subjected to running water condition.

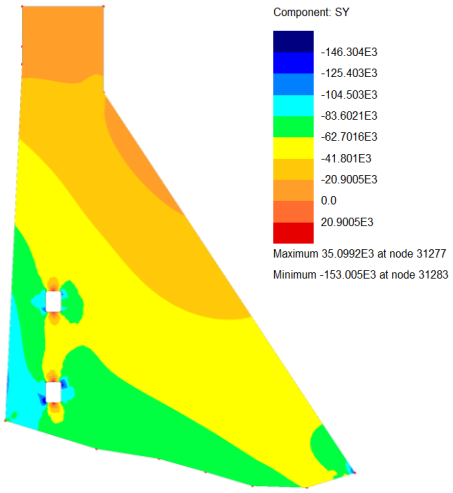
Bond strength set up



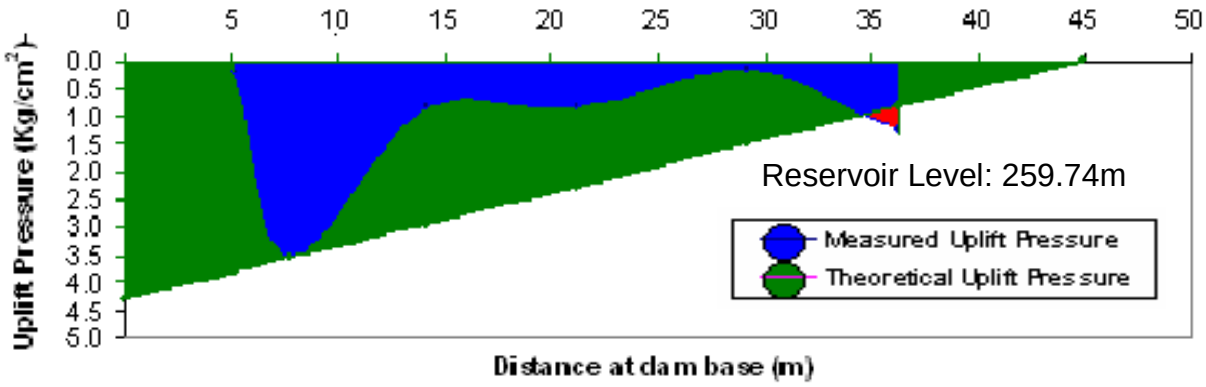
Double shear test

5204-ANALYSIS AND INTERPRETATION OF DAM INSTRUMENTATION DATA FOR PERIOD JANUARY 2013 TO DECEMBER 2013 FOR NON-OVERFLOW BLOCK 25, INDIRA SAGAR DAM,M.P.

92-meter high and 653 meter long Indira Sagar dam is a concrete gravity dam across river Narmada in Madhya Pradesh consisting of 27 blocks of which block nos 1 to 3 and 25 to 27 are non-overflow blocks while block nos. 4 to 24 form overflow (spillway) portion. Besides irrigation, the Project further envisages power generation of 1000 MW from 8 units of 125 MW each installed capacity. In order to monitor the structural behaviour of dam, various instruments such as Foundation Piezometers, Uplift Pressure Pipes, Extensometers, Reservoir Water Level Meters, No Stress Strain Meters; Thermometers etc. have been installed in Non-Overflow Block No.25 at different levels and varying distances from dam axis by M/s Encardiorite Systems under the supervision of Instrumentation group, CWPRS, Pune. Data from installed instruments are collected by Project officials every fortnight since year 2003 and sent to CWPRS at regular intervals for further studies. The studies include detailed analysis and plotting of data of various parameters along with reservoir water level Vs time, 2D Stress analysis by FEM using LUSAS ver.14.3 software of dam block for various load combinations, interpretation of results and comparison with design / computed values and plotting of isotherms from installed thermometer data in respect of Non-Overflow block no. 25. Studies though primarily cover the results between Jan 2013 to Dec 2013, for the sake of continuity, monitoring behavior of instruments for the entire period between January 2003 to December 2012 has also been covered. The pattern of measured Vertical Stress, Displacement and Strain has been in fair agreement with computed values by FEM. Measured uplift pressure exceeds theoretically computed values in downstream. For other parameters such as Temperature, Water level and Pore pressure, most of the instruments exhibited cyclic trend indicating regular dam behavior, remain within allowable limits and fairly match with computed values.



Distribution of Vertical Stress by 2D FEM



Comparison of Measured and Theoretical Uplift Pressure at dam base

5205-STUDIES FOR REPAIR OF DISTRESSED TRANSVERSE BEAM BETWEEN COLUMN 1 AND 1A OF UNIT NO.6 OF CAPTIVE POWER PLANT NO.1 OF ROURKELA STEEL PLANT, ODISHA

The Captive Power Plant No.1 (CPP-1) of Rourkela Steel Plant (RSP) in Odisha state was commissioned in two stages, unit Nos. 1,2 & 3 commissioned in 1959-60, whereas unit Nos. 4 and 6 commissioned in 1965-66. During operation of unit no. 6, excessive vibrations were felt in the generator portion. At the request of the project authority, Central Water & Power Research Station, Pune carried out non-destructive testing (NDT) of columns, beams and pedestals of the unit no. 6 during Feb-March 2013. Based on results of NDT, transverse RCC beam between column 1 and 1A has been found distressed due to long term exposure to adverse environment, effect of continuous machine vibrations and aging effect.

Project Authority again requested CWPRS officials to inspect the damaged transverse reinforced concrete beam and suggest suitable repair methodology/ remedial measures. Accordingly, deck slab and transverse beam have been inspected. Repair/strengthening materials from different manufacturers have been assessed for their suitability by conducting laboratory studies, which includes determination of viscosity, pot life, bond strength, penetrability and any other specific test as per site conditions. The methodologies for repair of distressed beam using suitable repair material selected through the results of various tests and observations, have been presented in the report.

The NDT conducted on post treatment of distressed beam, has indicated substantial improvement in the elastic and strength parameters of the beam indicating effectiveness of the methodology and treatment.

View of captive power plant - 1, R.S.P., Rourkela

View of distressed beam

5215-IDENTIFICATION OF REPAIR MATERIALS AND REPAIR METHODOLOGY FOR ARRESTING SEEPAGE OF DIMBHE DAM, MAHARASHTRA

Dimbhe dam is a masonry dam built across river Ghod near Ambegaon in Pune district, Maharashtra. The height of the dam above lowest foundation is 72.1 m and the length is 852 m. The upstream face of the dam is provided with guniting to protect stone masonry from ingress of water through masonry joints and weak zones and also as a protection against wearing of surface due to environmental effects and attack of hazardous materials carried by water. Seepage was observed through the body of dam and in the galleries. Seepage/leakage was noticed through the gallery and the discharge through the seepage collection drains in gallery. The quantity of water percolating through body of dam was large and quite alarming to the structure. Sweating was also observed on the d/s surface of the dam. It was therefore, required to investigate the causes of seepage and to devise suitable remedial measures for arresting it.

The studies for identification of suitable repair materials and to devise suitable repair methodology for arresting seepage were undertaken. Accordingly the dam was inspected to investigate the causes of seepage. The causes noted were cracking and non uniform gunitting on upstream face, etc. It was decided to perform pointing of masonry joints using suitable repair material. The material for pointing was identified by conducting laboratory tests on three different types of repair materials. Studies are conducted to identify suitable repair materials primers for bonding, mortar for raking and pointing etc. The studies include determination of compressive strength, bond strength, tensile strength, modulus of elasticity, abrasion resistance, and any other specific test as per site conditions. The materials from different manufacturers were assessed in laboratory for meeting the specific requirements. From the results of various tests, observations made on the mortar during mixing and casting and the tests and observations, the suggestions and recommendation for use of different materials etc have been presented in the report.

In addition to the treatment to upstream face by pointing of masonry joints, other measures such as, removal of rusted steel parts in masonry, filling of cavities in masonry and grouting dam body are also suggested to arrest seepage.

View of Dimbhe dam

Seepage seen on d/s face

5219-ASSESSMENT OF QUALITY OF MASONRY OF BHANDARDARA DAM, AHMEDNAGAR, MAHARASHTRA

Wilson Dam commonly known as Bhandardara Dam is a gravity structure built in uncoursed rubble masonry in hydraulic lime mortar with coursed crushed sand. It is built across river Pravara, near village Bhandardara in Akole taluka of Ahmednagar district in Maharashtra. The height of the dam above lowest foundation is 82.32m, width at foundation level 79.28 m and the total length 598.30 m and constructed during 1910-1926. The gross storage created behind the dam up to FRL 744.725 m is 312.60 Mcum.

In the post monsoon inspection in the year 2008, leakages and oozing at various places was observed on D/s face. In this context, Project authority requested CWPRS to conduct non destructive tests as well as laboratory studies on extracted cores from masonry portion of Bhandardara Dam required to ascertain stability of dam. Project authority supplied extracted cores of 150 mm diameter from two bore-hole numbers 3 & 4 to CWPRS for evaluation. Extracted cores were dressed to required size to determine their strength properties as per the standard practice/procedure mentioned for testing ordinary concrete specimens. Only 14 cores found suitable for compression testing, has been tested for determination of compressive strength. The compressive strength computed from compression testing results of extracted cores found to vary from 32.83 kg/cm^2 to 84.92 kg/cm^2. Whereas four cores found suitable for split tension testing has been tested for determination of split tensile strength. The split tensile strength computed from split tension testing results of extracted cores found to vary from 4.2 kg/cm^2 to 11.2 kg/cm^2. The mass dry density of masonry varies from 2197 - 2472 kg/m^3. The percentage of mortar in colgrouts masonry samples computed from tested core specimen varies from 23.3 to 57.5.

General view of Bhandardara dam

Compression test under progress

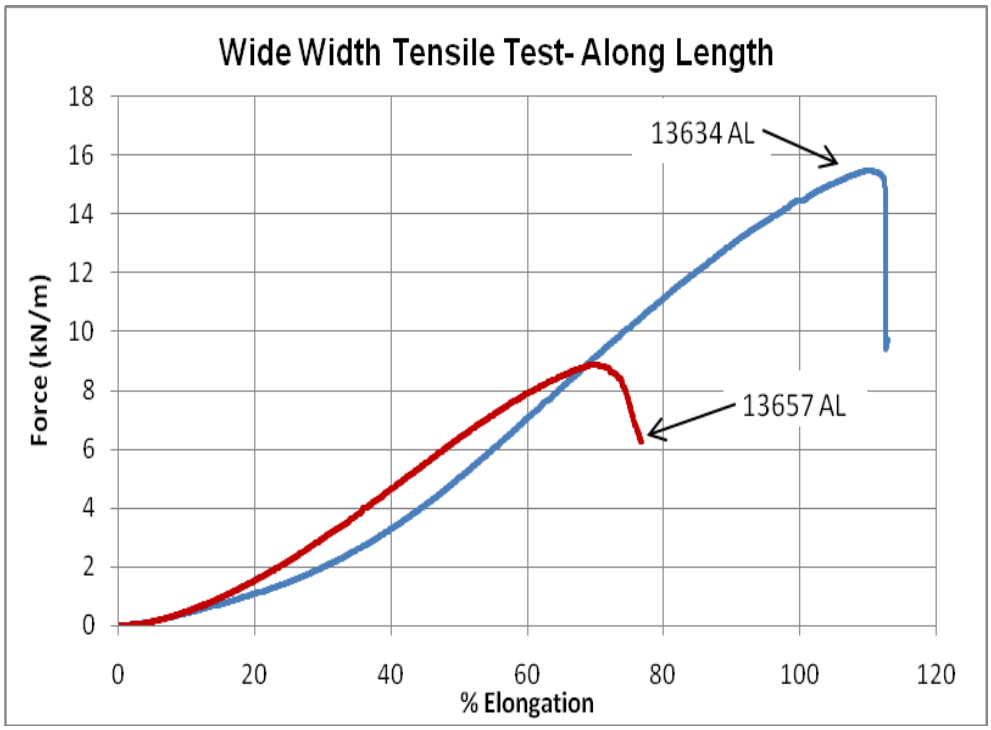
Split tension test assembly

5230-DETERMINATION OF GEOTEXTILE PROPERTIES OF GEOBAGS FROM WATER RESOURCES DEPARTMENT, SIWAN, BIHAR

Geobags are bags made up of geotextile material and filled with sand, gravel or lean concrete. Quality checks with respect to various properties of the geotextile material used for making of geobags are essential in view of their use in different applications involving construction of structures such as revetments, groynes, breakwaters, etc. Different laboratory tests which involve determination of various physical, mechanical and hydraulic properties are performed on the geotextile material of geobags to ascertain whether the material used conforms to the required specified values.

Geobags filled with sand are used for anti erosion work at various sites in Bihar by Water Resources Department (WRD), Patna. Shri Dinesh Kumar Chaudhari, Chief Engineer, Water Resources Department, Siwan requested CWPRS to carry out tests of Geotextile material of Geobags in the geosynthetics laboratory of CWPRS. Laboratory tests were conducted on 25 Geobag samples of size 1 m X 0.7 m, as per ASTM standards. Properties of geotextile material such as i) Thickness, ii) Mass per unit area, iii) Apparent Opening Size (AOS), iv) Wide width tensile strength, v) Trapezoidal tear Strength and vi) Static puncture strength were determined.

The test results indicated large variation in values. Thickness of geotextile material varied from 1.31 mm to 3.46 mm whereas Mass per unit area varied from 255 GSM to 406 GSM. The Wide Width tensile strength results were in the range of 6.40 kN/m to 21.80 kN/m and elongation reported was 48.9% to 109.4%. The Static puncture strength values ranged from 1429.3 N to 3136.3 N. Trapezoidal Tear Strength results were in the range of 174.7 N to 529.7 N. It was recommended to compare the test results of individual samples with the required values before selection of samples for field application.



Graph of load vs. elongation in wide width tensile test on geotextiles

5231-ROCK MECHANICS STUDIES FOR KUMBHE H.E PROJECT, MAHARASHTRA

The Kumbhe Hydroelectric Project with an installed capacity of 10 MW is being constructed in Mahad, District–Raigad, Maharashtra, India. An earthen dam of length 610 m and 56 m height is being constructed for storage of water. The water is diverted by water conductor system of length 3850 m excavated through the rock. Rock mechanics studies have been undertaken by rock mechanics division of CWPRS, Pune to measure various engineering properties of rock core samples extracted from different depths and insitu studies in the water conductor system.

The rock core samples from Kumbhe Hydroelectric Project are tested in CWPRS laboratory. The average values of engineering properties of rock estimated by testing of rock core samples in laboratory are given below

Density (gm/cc)	2.67,	elastic modulus (dynamic) GPa	45.60,
Percentage of water absorbed	1.07%,	elastic modulus (static-dry) GPa	42.50,
Compressive Strength (MPa)	78.03,	elastic modulus (static-saturated) GPa	37.50,
Tensile strength (MPa)	7.50,	Poisson's ratio	0.178

The rock core samples does not fully represent the rock mass existing at site, as joints existing in the rock mass are not represented in the rock cores. Due to the presence of joints in the rock, deformation modulus may have lesser value than the elastic modulus values. So insitu tests are carried out to determine the deformation modulus. The excavated length of head race tunnel which was available for flat jack tests has different types of rock mass from Chainage 88 m to 1230 m. The deformation modulus of the different rock mass tested by flat jack are given as under

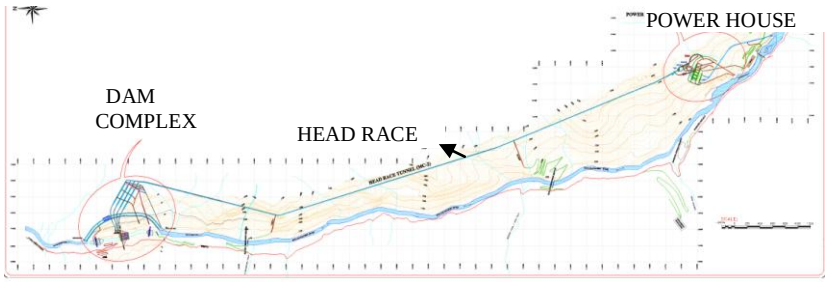
Type of rock	Deformation modulus (GPa)
Basalt rock	42.40
Jointed Basalt rock mass	21.32
Highly Jointed Basalt rock mass	9.16
Volcanic Breccia rock mass	22.03
Breccia rock mass	36.70

The Static Modulus of Deformation (E_M) of Basalt rock mass at Ch 308 m is found as 42.40 Gpa, which is comparable with elastic modulus(static-dry) of Basalt rock mass tested in laboratory. Due to saturation the deformation modulus, E_M obtained by Flat jack tests has to be reduced as 0.88 times, for all types of rocks. The induced tangential stress (P_θ) around the boundary of the excavated section of tunnel is found to vary between 0.79 to 13.49 MPa and those parallel to axis of the opening (P_H) is found to vary between 9.30 to 10.06 MPa. The induced stresses are found to be compressive. Due to the variation of the values of deformation modulus for different type of rocks in the water conductor system, the thickness of lining may vary if it is to be provided for support purposes. For surface smoothening the thickness of shotcrete may be kept same. On the basis of the values of different parameters e.g. Density, Water absorption, Compressive strength, (σ_c), Tensile strength, (σ_t), Elastic modulus,(E_L), Poisson's ratio, ν, the rock core samples can be classified as hard category having high strength.

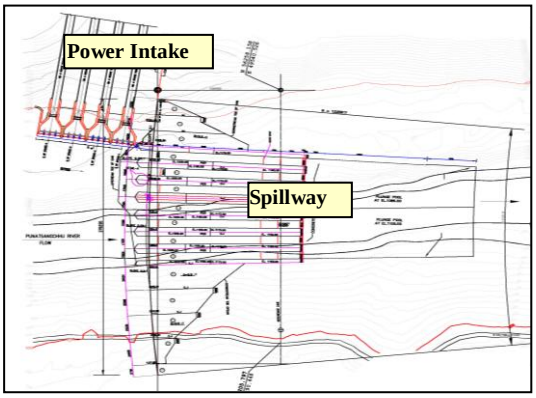
5235-HYDRAULIC MODEL STUDIES FOR POWER INTAKE OF PUNATSANGCHHU- I H.E. PROJCT, BHUTAN, 1:35 SCALE MODEL

Punatsangchhu hydro-electric project (Bhutan) is a run-of-the-river scheme envisages construction of a 130 m high and 239 m long (at the top) concrete gravity dam and an underground Power Station of 1200 MW capacity. The water conductor system for power generation consists of four numbers of intakes, one headrace tunnel, two numbers of pressure shafts, six numbers of penstocks, six Francis turbine units with design discharge of 64.26 m^3/s and gross operating head of 328 m. Figure 1 shows the layout plan of the water conductor system of project. Figures 2 show the general layout plan of the dam, spillway and power intakes.

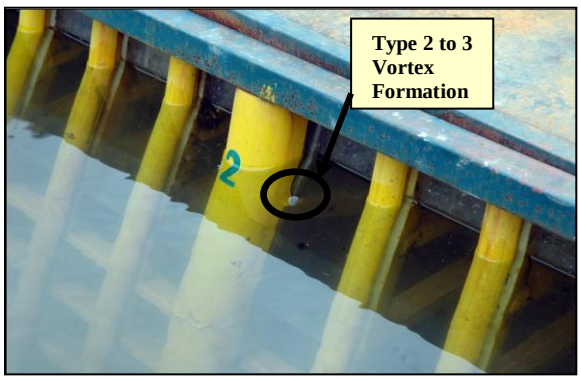
Hydraulic model studies were conducted in a 1:35 geometrically similar scale model to study the flow conditions in the reservoir in the vicinity of power intakes and to suggest remedial measures if air entraining vortex formation is occurring in front of power intakes. The studies were conducted for combination of operations of intakes and sluice spillways with discharge 2500 m^3/s at maximum draw down level (MDDL) and full reservoir level (FRL). Observations indicated occasional formation of vortices of type 2 i.e. surface swirl with nominal drop in water surface to type 3 i.e. dye core vortices without ingesting floating materials. Vortices formed due to flow separation from intake main piers. Photograph 1 shows the formation of vortex at intake. Small stagnation zone upstream of intake was observed. The coherent surface swirl and dye core vortices are not air- entraining vortices and therefore submergence provided at intake is adequate and anti-vortex devices are not required. The performance of intake with respect to flow conditions was found satisfactory.



Layout plan of the water conductor system



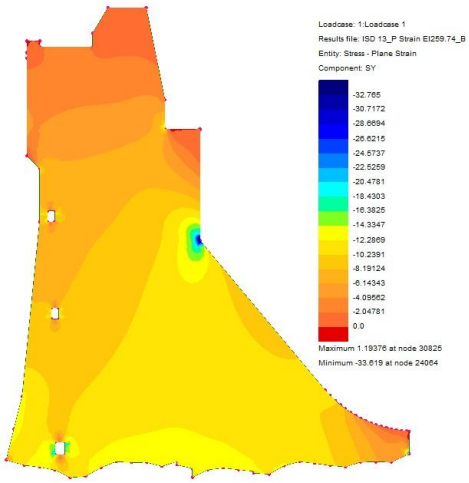
General layout plan of the dam, spillway and power intakes



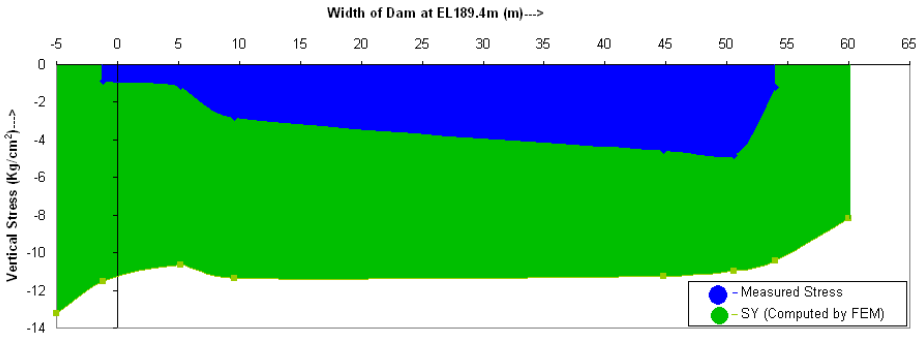
Formation of vortex at Intake

5244-ANALYSIS AND INTERPRETATION OF DAM INSTRUMENTATION DATA FOR PERIOD JANUARY 2013 TO DECEMBER 2013 FOR SPILLWAY BLOCK 13, INDIRA SAGAR DAM, M.P.

92-meter high and 653 meter long Indira Sagar dam is a concrete gravity dam across river Narmada in Madhya Pradesh consisting of 27 blocks of which block nos 1 to 3 and 25 to 27 are non-overflow blocks while block nos. 4 to 24 form spillway portion. Besides irrigation, the dam further envisages power generation of 1000 MW from installed 8 units of 125 MW each. In order to monitor the structural behaviour of dam, various instruments such as Foundation Piezometers, Stress meters, Extensometers, Reservoir Water Level Meter, Strain meters, No Stress Strain Meters; Thermometers etc. have been installed in Spillway Block No.13 at different levels and varying distances from dam axis by M/s Encardiorite Systems under the supervision of Instrumentation group, CWPRS, Pune. Data from installed instruments are collected by Project officials every fortnight since year 2003 and sent to CWPRS at regular intervals for further studies. The studies include detailed analysis and plotting of data of various parameters along with reservoir water level Vs time, 2D Stress analysis by FEM, using LUSAS ver.14.3 software of dam block under various load combinations, interpretation of results and comparison with design / computed values and plotting of isotherms from installed thermometer data in respect of Spillway block no. 13. Studies though primarily cover the results between Jan 2013 to Dec 2013, for the sake of continuity monitoring behavior of instruments for the entire period between January 2003 to December 2013 has been covered. The pattern of measured Vertical Stress, Displacement and settlement has been in fair agreement with computed values by FEM. Measured uplift pressure remains less than the computed values as per BIS criteria. For other parameters such as Temperature, Water level and Pore pressure, most of the instruments exhibited cyclic trend indicating regular dam behavior, remain within allowable limits and fairly match with computed values.



Distribution of Vertical Stress by 2D FEM



Comparison of measured and computed uplift pressure at dam base

5245-IDENTIFICATION OF REPAIR MATERIALS AND REPAIR METHODOLOGY FOR STRENGTHENING OF KRISHNARAJASAGAR DAM, KARNATAKA

Krishnarajasagar dam is multipurpose project formed by the construction of a dam across the river Cauvery, situated about 16 km north-west of Mysore city in south India. The length of the dam is 2621 m and height 42.62 m. Commencement of construction was started in November 1911 and completed in the year 1932. The dam is amongst the first in the world to use automatic gates and represents the marvel of civil engineering of pre-independent India. The reservoir ensures a steady supply of water for the generation of power at Shivanasamudram Shimsa Power Station. The upstream face of dam showed many distresses on the visible areas i.e. above reservoir water level. It was observed during the inspection that pointing material had peeled off giving way to water. Due to loss of pointing and filling material, cavities have formed inside the body of dam. The openings of masonry joints were found to be wide and deep. At many places the stones were found to be loose and dislodged.

Studies were conducted to identify suitable repair materials, primers for bonding, and mortar for raking and pointing. The studies include determination of pot life, bond strength with rock and concrete under tension and shear , compressive strength, bond strength, tensile strength and abrasion resistance. The materials from different manufacturers were tested in laboratory for assessing their suitability to meet specific requirements.

From the results of various tests and observations made on the primer system and mortar during mixing and casting, the suggestions regarding repair methodology and recommendation for use of materials have been presented in the report.

View of Krishnarajasagar dam

Wide openings in masonry joints

5262-IDENTIFICATION OF SUITABLE REPAIR MATERIALS AND REPAIR METHODOLOGY FOR TREATMENT OF UPSTREAM FACE OF SHIVSAGAR DAM, MAHARASHTRA.

25 m high and 511 m long, Shivsagar masonry gravity dam is located at Lonavala, 80 km from Pune in Maharashtra state. The reservoir of dam caters to drinking water and navigation requirements of Indian Naval Services (INS) Shivaji, Lonavala. The upstream face of the dam has been capped with 1.5 m -2.0 m thick concrete of grade M-15 to restrict entry of water through the masonry portion of the dam. Over the years, heavy leakage of water through dam body and galleries has been reported by the project authorities. Project authority, requested CWPRS to conduct the various laboratory tests for identification of suitable repair material and repair methodology for treatment of upstream face of Shivsagar dam for arresting seepage in the dam.

Studies are conducted to identify suitable repair materials, primers for bonding, and mortar for raking and pointing. The studies include determination of compressive strength, tensile strength, modulus of elasticity, abrasion resistance and bond strength under tension and shear mode. The repair methodology has been suggested based on the past experience and as per site conditions.

The materials from different manufacturers were assessed in laboratory for meeting the specific requirements. From the results of various tests and observations made on repair materials, all the repair material samples, except BASF, were found to be suitable for treatment to the U/s concrete surface of Shivsagar dam.

U/s view, Shivsagar dam

Cavities in the u/s of Shivsagar dam

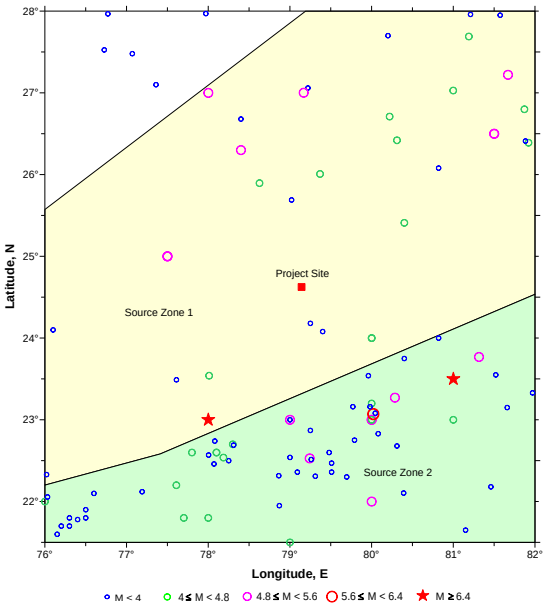
APPLIED EARTH SCIENCES

5183-ESTIMATION OF SITE-SPECIFIC SEISMIC DESIGN PARAMETERS FOR BANSUJARA DAM, MADHYA PRADESH

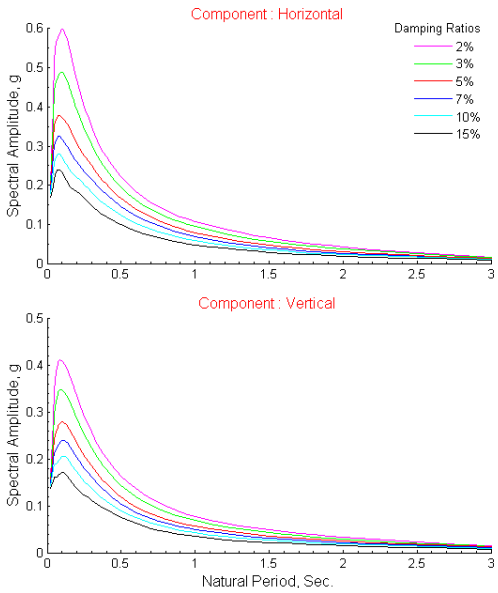
The Bansujara Dam Project (BDP) envisages construction of a 26.44 m high and about 1500 m long composite dam with 285 m long central spillway across the Dhasan River, a tributary of the Betwa River, near villages Ban in Chhatarpur district and Sujara in Tikamgarh district of Madhya Pradesh state. The dam site is in the Bundlekhand gneissic terrain of Archaean-Proterozoic age, which is known as Bundlekhand Craton, and is bound by the tectonic features associated with very low level of seismicity. The site lies in Zone II of the seismic zoning map of India (IS : 1893, Part-1, 2002).

Using regional data on tectonic features and associated seismicity, along with local geotechnical characteristics, site-specific seismic parameters have been estimated for earthquake resistant design of the various components of the project, using both deterministic and probabilistic approaches. The deterministic target spectra are governed by the MCE of 'floating' earthquake magnitude 6.0 with its closest epicentral distance from the dam site varying from 0 to 25 km. The response spectra of horizontal and vertical components, with a confidence level of 50% and damping ratio of 5% for this earthquake provide the basic deterministic target spectra for generating the MCE level of ground motion. The probabilistic target spectra for MCE condition are computed with a confidence level of 96% in 100 years by estimating the total expected seismicity in terms of the recurrence rate of earthquakes in different magnitude intervals for various seismic sources in the region. The difference in the deterministic probabilistic spectral amplitudes is less than 25% at the entire periods of interest for horizontal and vertical components. Hence the envelops of the deterministic and probabilistic spectra have been taken to be the target spectra of ground motion. For the DBE level of ground motion, the probabilistic spectra are obtained for a return period of 475 years and the deterministic spectra have been estimated with one standard deviation less than that of MCE. For the DBE condition also the envelops of the deterministic and probabilistic spectra have been taken to be the target spectra of ground motion as the difference in their amplitudes are less than 25% in the entire period range for both components.

The 5% damped target response spectra thus obtained, are used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion are found to be 0.148 g and 0.105 g, for MCE and and 0.099 g and 0.066 g for DBE conditions respectively. The acceleration response spectra for damping ratios of 2%, 3%, 5%, 10% and 15% of critical are computed from the design accelerograms.



Seismic sources in the region of Bansujara dam site along with the epicenters of available data on past earthquakes



Design response spectra with damping ratios of 2%, 3%, 5%, 10% and 15% critical as computed from the MCE level of accelerograms for horizontal and vertical components of ground motion

5192- MONITORING OF BLAST VIBRATIONS DURING UNDERWATER BLASTING FOR JAWAHARLAL NEHRU PORT, NAVI MUMBAI, MAHARASHTRA

The Jawaharlal Nehru Port Trust, Navi Mumbai, Maharashtra has undertaken major expansion program which involves capital dredging of about 1,80,000 m^3 of rock by underwater blasting in Shipping Channel, turning circle and berth pocket areas. With a view to ensure safety of the nearby structures and in particular the Elephanta caves located near the blasting sites against blast vibrations, M/s Boskalis International B.V., Mumbai requested Central Water and Power Research Station (CWPRS), Pune to monitor the blasting operations. Reviewing the published literature and considering the importance of various structures around the blasting sites, peak particle velocity of 1 mm/s for Elephanta Caves and 10 mm/s for other structures have been considered as safe vibration levels. The blasting operations were carried during 24.05.2013 to 12.12.2013. During the actual blasting, 165 mm diameter holes were drilled to the required depth in 3m×3m square pattern. KELVEX-P, CPT explosives with NONEL delay detonators were used for blasting. Each hole was blasted with a separate delay.

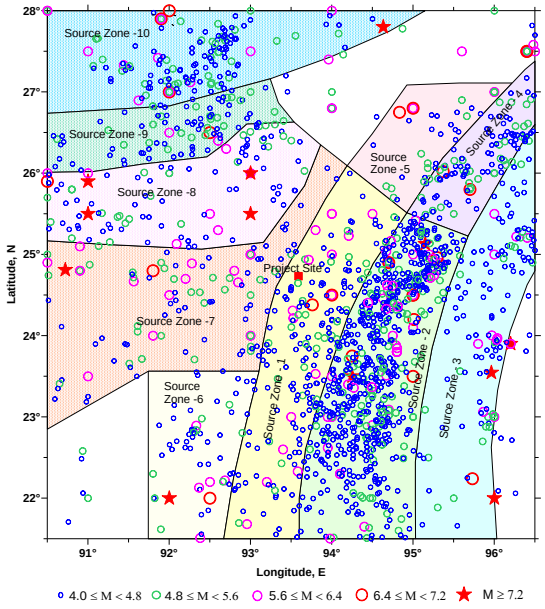
Depending on the depth, the maximum charge weight per delay varied from 6.25 kg to 37.50 kg. The blast vibrations were periodically monitored at multiple locations using three component engineering seismographs by CWPRS officers and in the intermittent period, blasts were monitored by M/s RKS Co. Chennai on behalf of M/s Boskalis International, Mumbai. The ground vibrations resulted from the ongoing blasting operations were monitored near important structures viz. APM Container Terminal Berth, JNPT Berth, DP World Berth, Liquid Cargo Jetty, ONGC Jetty, Elephanta/ Rajbandar Jetty, Elephanta Caves, ONGC Administration Building, Electrical Building and CISF Quarters, Temples and houses in Rajbandar and Morbandar village, etc. From the analysis of blast vibration monitoring data it is concluded that the observed vibrations at important locations were within the adopted safe levels and the underwater drilling and blasting carried out for capital dredging of hard rock at JNPT, Navi Mumbai have been completed safely.

5208-ESTIMATION OF SITE-SPECIFIC SEISMIC DESIGN GROUND MOTION FOR LOKTAK DOWNSTREAM HYDRO ELECTRIC PROJECT, MANIPUR

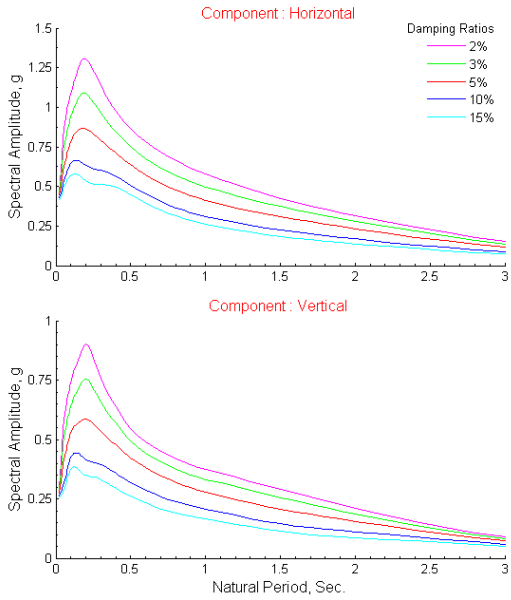
The Loktak Downstream Hydro Electric Project (LDHEP) envisages the construction of a 30 m high concrete gravity dam across the river Liematak in Manipur. The project would provide an annual generation of 330.24 MU with a surface powerhouse having 2 units with installed capacity of 66MW. The project site is located in the highly seismic Himalayan tectonic province with very complex geological setup. As per the seismic zoning map of India (IS: 1893-2002), the entire northeast India is included in zone-V, the most severe seismic zone in the country. The LDHEP is thus located in the highly seismic northeast region of India with very complex geological and tectonic setup. There are two tectonically distinct sources for the seismicity; the shallow earthquakes in the upper crust and the deeper earthquakes within the Indian plate subducting below the Burmese plate.

Using regional data on tectonic features and associated seismicity, along with local geotechnical characteristics, site-specific seismic parameters have been estimated for earthquake resistant design of the various components of the project, using both deterministic and probabilistic approaches. The deterministic estimate is found to be governed by a maximum credible earthquake (MCE) of magnitude 7.5 in the subduction zone with a closest rupture distance from the fault rupture plane in the subducting slab of 119.6 km. The 5% damped response spectra of horizontal component, with a confidence level of 84% and 50% for this earthquake provide the basic deterministic target spectra for generating the MCE and DBE level of ground motion respectively. The probabilistic target spectra for MCE and DBE conditions are computed with return periods of 2500 and 475 years respectively, by estimating the total expected seismicity in terms of the recurrence rate of earthquakes in different magnitude intervals for various seismic sources in the region. Since the difference between the deterministic and probabilistic spectral amplitudes is less than 25% at the period of interest, the envelops of the deterministic and probabilistic spectra have been taken to be the target spectra for MCE as well as the DBE level of horizontal ground motion. The two third of horizontal ground motion is taken to be the target spectra of vertical ground motion.

The 5% damped target response spectra thus obtained, are used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion are found to be be 0.38 g and 0.243 g, for MCE and 0.224 g and 0.159 g for DBE conditions respectively. The acceleration response spectra for damping ratios of 2%, 3%, 5%, 10% and 15% of critical are computed from the design accelerograms.



Seismic sources in the region of Loktak Project site along with the epicenters of available data on past earthquakes

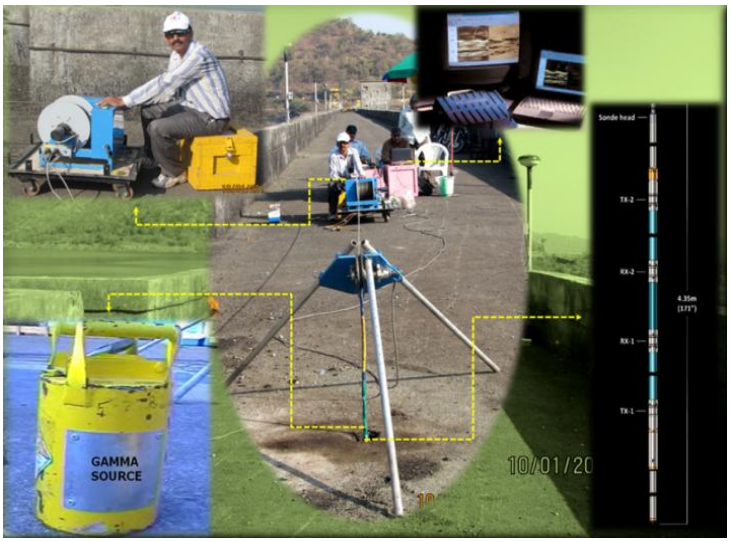


Design response spectra with damping ratios of 2%, 3%, 5%, 10% and 15% critical as computed from the MCE level of accelerograms for horizontal and vertical components of ground motion

5211-NUCLEAR DENSITY LOGGING AND TRACER STUDIES FOR DELINEATING PATH OF SEEPAGE OF DIMBHE MASONRY DAM, PUNE, MAHARASHTRA

Dimbhe dam, constructed on River 'Ghod' in Ambegaon Taluka, Pune, is a masonry dam having height of 72.10 m and length of 852 m. The dam was constructed in the year 2001, with a total storage capacity of 13.5 TMC. Subsequently, heavy leakages were observed through the masonry in both the galleries as well as in the downstream face of the dam. In view of this, the Dam Safety Review Panel, recommended to study non-destructive testing, nuclear logging, seismic tomography of the dam to adopt suitable remedial measures to stop seepage. Accordingly, nuclear logging comprising gamma-gamma, neutron and caliper logging were conducted in the Nx (76 mm) size borehole drilled at Ch. 642 m on the dam top and tracer studies were conducted by injecting tracer in the reservoir at Ch. 642 m during the full reservoir level (post monsoon) and at low reservoir level (pre-monsoon) around Ch.307 m, to ascertain seepage through foundation if any. The area under study falls in the Bhima – Ghod River system in the northern part of Pune district. The entire area is underlain by the basaltic lava flows of upper Cretaceous to lower Eocene age. The Nuclear and caliper logging was carried out using RG well logging unit in the Nx size bore holes drilled at Ch. 642 m in the body of the dam. It was observed that out of the total drilled depth of 56 m, only about 20 m depth from the dam top was available for logging. Tracer studies were conducted by injecting sodium fluoroscein dye in the reservoir at depth of around 23 m from dam top near Ch. 642 m.

The samples were collected on the downstream side at Ch. 648 (large flow from the body of dam), Ch. 630, V notch outside the Inspection Gallery, jet like flow from the wall of foundation gallery at Ch. 535, and from porous hole in the foundation gallery at Ch 650. The samples were analyzed in the TDS700 Laboratory fluorometer. The results of the nuclear logging studies indicated that the density of masonry varied between 2.25 gm/cm^3 and 3.0gm/cm^3.The caliper logs indicated the variations in the borehole diameter and indicated the presence of cracks. From the studies low density zone was demarcated at around 13 m depth. The results of the tracer studies indicated the arrival of tracer in seepage flows observed on the downstream face point after 15-30 min from injection and maximum concentration was recorded after one hour. Arrival of Tracer was visually seen in the 'V' Notch near the inspection gallery after 45 min. The results of the tracer studies conducted at low reservoir level did not indicate any arrival of tracer at different observation points. As such the possibility of seepage from the foundation was ruled out. The interconnectivity between the reservoir and seepage zones in the downstream side of the dam through the weak zones in the body of the dam was established. Based on the results it is recommended that suitable remedial measures like grouting, may be undertaken at weak zones in the body of the dam identified by nuclear logging and path of seepage ascertained by tracer studies.



Field set up for welllogging

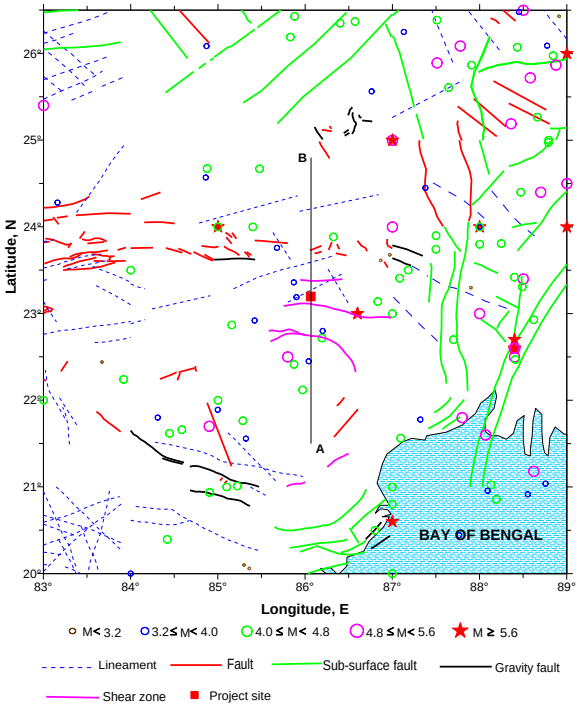
Confirmation of arrival of tracer

5220-ESTIMATION OF SITE-SPECIFIC SEISMIC DESIGN PARAMETERS FOR TURGA PUMPED STORAGE PROJECT, WEST BENGAL

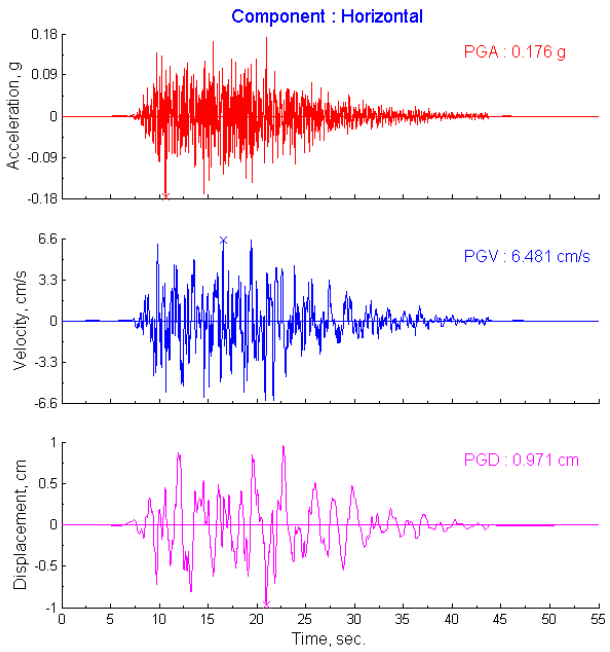
The West Bengal State Electricity Distribution Company Limited (WBSEDCL) has envisaged construction of Turga Pumped Storage Project (TPSP) with installed capacity of 1000 MW in the Ayodhya Hills, Purulia District, West Bengal over the Turga nala a tributary of Subarnarekha river. The Turga Pumped Storage Project would consist of a rock fill dam, 796 m long, 79 m high at the upper level and a 502m long rock fill dam, 69 m high at the lower level. The site lies in Zone III of the seismic zoning map of India.

Using regional data on tectonic features and associated seismicity, along with local geotechnical characteristics, site-specific seismic parameters have been estimated for earthquake resistant design of the various components of the project, using both deterministic and probabilistic approaches. The deterministic target spectra are governed by the MCE of magnitude 6.2 at an epicentral distance of 9.4 km from the dam site. The response spectra of horizontal and vertical components, with a confidence level of 50% and damping ratio of 5% for this earthquake provide the basic deterministic target spectra for generating the Maximum Creditable Earthquake (MCE) level of ground motion. The probabilistic target spectra for MCE condition are computed with a confidence level of 96% in 100 years by estimating the total expected seismicity in terms of the recurrence rate of earthquakes in different magnitude intervals for various seismic sources in the region. The difference in the deterministic and probabilistic spectral amplitudes is more than 25% at the period of interest for horizontal and vertical components. Hence the average of the deterministic and probabilistic spectra have been taken to be the target response spectra of ground motion. For the DBE level of ground motion, the probabilistic spectra are obtained for a return period of 475 years and the deterministic spectra have been estimated with one standard deviation less than that of MCE. For the Design Basic Earthquake (DBE) condition the envelop of the deterministic and probabilistic spectra have been taken to be the target spectra of ground motion for both components.

The 5% damped target response spectra thus obtained, are used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion are found to be 0.176 g and 0.128 g, for MCE and 0.108 g and 0.075 g for DBE conditions respectively. The acceleration response spectra for damping ratios of 2%, 3%, 5%, 7%, 10% and 15% of critical are computed from the design accelerograms.



Correlation of the epicenters of past earthquakes with major tectonic features in the region of site



MCE level of design accelerogram and the computed velocity and displacement records for the horizontal component of ground motion

5227-NON-DESTRUCTIVE TESTING OF REPAIRED BEAM OF T. A. FOUNDATION UNIT NO.6, ROURKELA STEEL PLANT, SAIL, ODISHA

The Turbo Alternator Unit No. 6 (TA # 6), a part of the Captive Power Plant No.1 (CPP-1) is used to meet the power requirement of Rourkela Steel Plant (RSP), Rourkela, Odisha. The unit was commissioned in the year 1965-66. The ultimate strength of the concrete used in construction of the foundation was 22.5 MPa. In the past, the RSP authorities have renovated the CPP-1 by replacing the old turbines by new ones, retaining their old frame type R.C.C. foundations and alternators. Subsequently, during operation of the TA # 6, excessive vibrations were felt in the generator portion. It was suspected that the excessive vibrations may be due to deterioration in quality of the foundation concrete. With a view to ascertain the in-situ quality of foundation concrete, non-destructive testing was carried out by Central Water and Power Research Station (CWPRS), Pune in 2013. The non-destructive testing of different parts of the concrete foundation was carried out by using ultrasonic pulse transmission technique. The studies identified a portion of about 2.1 m long and 1m thick concrete in deck slab / transverse beam between the columns 1 and 1A which is of poor quality. Based on these recommendations, the transverse beam was repaired by the Project Authorities.

To ascertain the efficacy of the repairing measures, the RSP authorities have entrusted the task of testing the quality of in-situ concrete of the repaired transverse beam to CWPRS Pune. Ultrasonic pulse transmission technique was deployed for evaluating the in-situ quality of the concrete of the repaired transverse beam. Portable Ultrasonic Non-destructive Digital Indicating Tester (PUNDIT) instrument with a pair of 54 KHz transducers from M/s CNS electronics, U.K. was used for testing of the concrete. The transverse beam was marked with 250 mm $\times$ 250 mm grid points and travel times of elastic compressional waves were measured at each grid point. Knowing the distance of travel path and corresponding travel time of elastic waves, compressional wave velocity was estimated at each grid point. A velocity criterion based on CWPRS experiences gained from testing of large number of concrete foundations over last several decades has been adopted to correlate the observed velocity with in-situ quality of foundation concrete of TA # 6. Considering the velocity of elastic compressional waves obtained and the velocity criteria adopted the in-situ quality of concrete of the transverse beam between columns 1 and 1 A has been inferred as of good to very good quality. The repairing measures undertaken by the project authorities have helped to improve the in-situ quality of the transverse beam between column 1 and 1A of TA # 6.

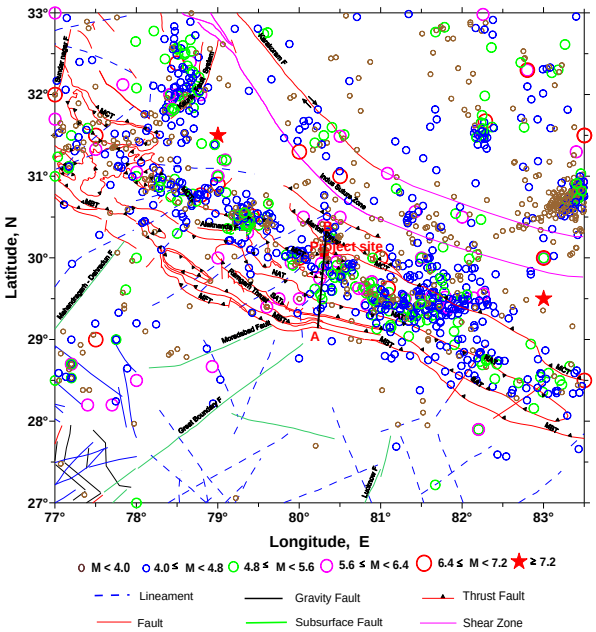
5254-ESTIMATION OF SITE-SPECIFIC SEISMIC DESIGN PARAMETERS FORGORIGANGA IIIA HYDRO ELECTRIC PROJECT, UTTARAKHAND

For detailed dynamic response analysis of important structures such as dams, the ground motion is required to be defined in terms of horizontal and vertical components of acceleration time history of the earthquake ground motion. Hence, seismic hazard analysis is a prerequisite for the safe and economical design of important projects. Design spectra for different damping values are evaluated to obtain the seismic coefficients required for preliminary design. The 5% damped target response spectra are estimated using deterministic and probabilistic seismic hazard analysis approaches. The target spectra are then used to generate the compatible design accelerograms and design spectra.

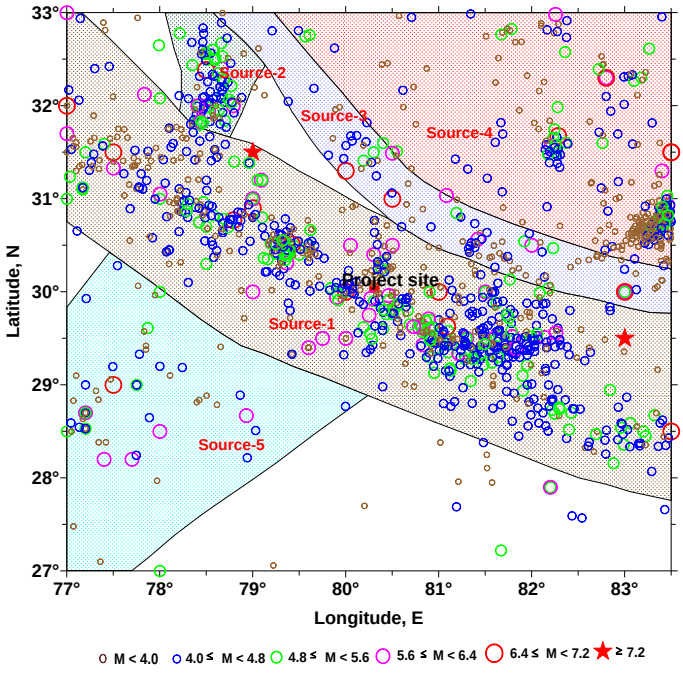
The proposed Goriganga IIIA Hydro Electric Project (GHEP) envisages the construction of 27.6 m high and 107 m long concrete gravity dam across river Goriganga, in Uttarakhand, with installed power generation capacity of 120MW. The site falls in the highly seismic Himalayan tectonic province, which has experienced several significant earthquakes in the past, with very complex geological and tectonic features. As per the zoning map of India (IS:1893-2002, Part-1) the site lies in seismic Zone V.

Since the deterministic spectrum of horizontal ground motion governed by the Maximum Credible Earthquake (MCE) magnitude of 8.0 on the MBT, it is taken to be the horizontal deterministic target spectrum. The target response spectrum in the probabilistic approach is estimated by considering the effect of all the earthquakes with appropriate spatial distribution in the various source zones during a specified exposure period. For MCE and DBE conditions, the probabilistic spectral amplitudes are obtained with a confidence level of 96 % and 81% respectively in 100 years. Since the difference between the deterministic and probabilistic spectral amplitudes, for both components of MCE and DBE conditions, is more than 25% at the periods of interest, the weighted averages of the two, using equal weights of 0.5, have been taken to be the target spectra.

The 5 % damped target response spectra thus obtained, are used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion are found to be 0.426 g and 0.313 g, for MCE and 0.267 g and 0.177g for DBE conditions respectively. The acceleration response spectra for damping ratios of 2%, 3%, 5%, 7%, 10% and 15% of critical are computed from the design accelerograms.



Correlation of the epicenters of past earthquakes with major tectonic features in the region of GHEP



Seismic source zones in the region of GHEP sites along with the epicenters of available data on past earthquakes

5258-TRACER STUDIES FOR DETECTING LEAKAGE THROUGH HILLOCK AT UPPER MANAR MEDIUM PROJECT, NANDED, MAHARASHTRA

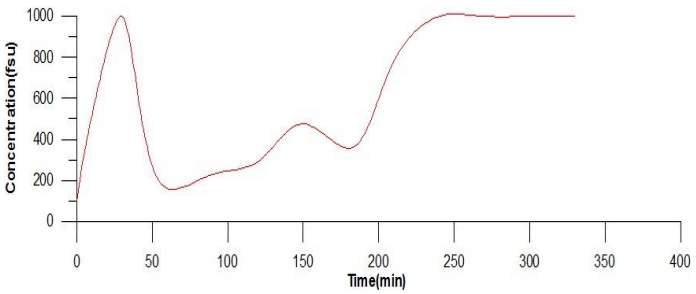
The Upper Manar Medium Project envisages the construction of a composite dam across River Manar, a tributary of River Manjara (a major tributary of River Godavari) near village Limboti, Tal. Kandhar, Dist. Nanded. The project consists of a 1000 m long Earth dam on the left flank, Non-Overflow (NOF) section on the left flank, masonry portion on the right flank with 180 m Overflow section, and 30 m NOF section on right flank. Beyond RD 1300 m on the right flank, a key wall was constructed (RD 1300 m to RD 1317 m). Geologically, the area comprises jointed/columnar basalt and amygdaloidal basalt. Near the earthen junction at the right flank, a spring and few leakage sites were observed in the hill. To establish interconnection between the reservoir water and the spring and leakages on the right flank, tracer studies were undertaken.

The studies were carried out using sodium fluoroscein tracer at borehole locations, two on Key-wall section and one on hillock adjacent to key-wall at a higher elevation. At the time of injection of tracer in a particular borehole, the other boreholes and spring discharge location were treated as seepage monitoring points. The samples were collected and monitored every 10 minutes and further the samples were analyzed using the fluorometer. Tracer was also injected from a small dinghy boat in the reservoir opposite the portion of drainage gallery where a cavity was located and the samples collected in the drainage gallery at selected seepage locations.

The results indicated that the sodium fluoroscein tracer injected in borehole at the key wall arrived almost instantaneously in the in borehole situated near the spring as well as adjacent to injection borehole. But the arrival of tracer was not observed in the spring water. Similarly, when the sodium fluoroscein dye was injected in the borehole located on the hillock, arrival of tracer was observed after about 5 hrs in the spring water but not in the borehole located near the spring.

Based on the tracer studies, it can be concluded that that reservoir water was escaping through the key wall junction down through the borehole near the spring. Also the reservoir water was being discharged through the hillock into the spring. The reservoir water was seeping into the drainage gallery through the large cavity/porous hole in the floor of the gallery as well as through the joints and porous pipes installed. In order to reduce / stop the seepage, it was recommended that the copper plate or some other arrangements at the junction between the key-wall and abutment need to be checked or replaced. As the abutment was getting recharged by reservoir water, it was suggested to monitor the reservoir level and measure the discharge through seepage points. The particular level of reservoir for which maximum discharge is observed needs to be monitored and abutment may be treated suitably by bentonite grouting or sand piling at that level.

Leakage on the RH side of the dam



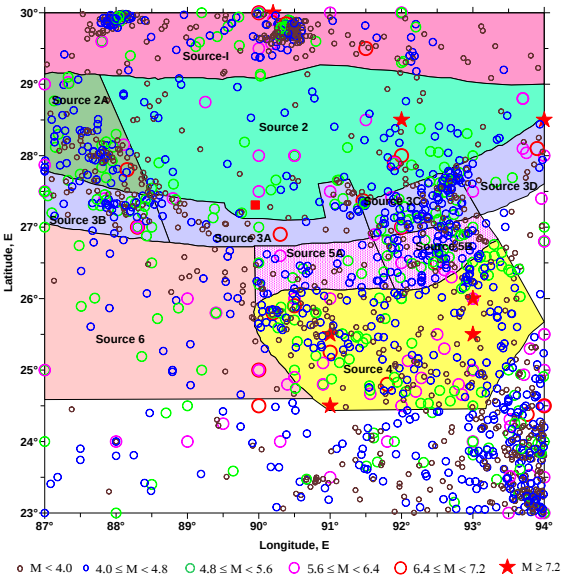
Arrival of tracer in borehole near spring

5274-ESTIMATIO|N OF SITE-SPECIFIC SEISMIC DESIGN PARAMETERS FOR PUNATSANGCHHU-II HYDRO ELECTRIC PROJECT, BHUTAN

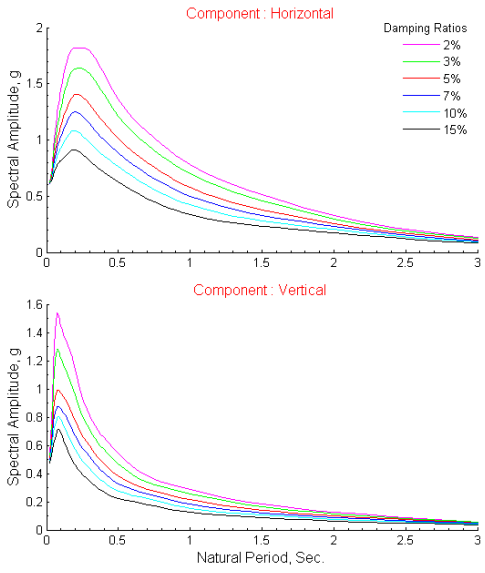
The Punatsangchhu-II Hydro Electric Project envisages the construction of a 86 m high and 217.5 long concrete gravity dam. The underground power house has an installed capacity of 1020 MW. The project is a run-off-the river scheme in Wangdur Phodarang district of Western Bhutan. The dam is proposed to be constructed across river Punatsangchhu. The project site is located in the highly seismic Himalayan tectonic province, which is having complex geological setup.

Using regional data on tectonic features and associated seismicity, along with local geotechnical characteristics, site-specific seismic parameters have been estimated for earthquake resistant design of the various components of the project, using both deterministic and probabilistic approaches. The deterministic estimate is found to be governed by a maximum credible earthquake (MCE) of magnitude 7.5 on the Main Central Thrust at a closest distance to fault rupture plane of 19.3 km. The 5% damped response spectra of horizontal and vertical components, with confidence level of 84% and 50% for this earthquake provide the basic deterministic target spectra for the MCE and DBE levels of ground motion respectively. The probabilistic target spectra for MCE and DBE conditions are computed with return periods of 2500 and 475 years respectively, by estimating the total expected seismicity in terms of the recurrence rate of earthquakes in different magnitude intervals for various seismic sources in the region. Since the difference between the MCE level of deterministic and probabilistic spectral amplitudes, for horizontal component, is less than 25% at the period of interest the envelope of both the spectra has been taken to be the target response spectra. For the vertical component, as the difference is greater than 25% at the period of interest, the average of both the spectra with equal weights has been taken to be the target response spectra. For the DBE level of ground motion, since the difference between the deterministic and probabilistic spectral amplitudes is greater than 25% at the period of interest for horizontal and vertical components, the average of both the spectra with equal weights has been taken to be the target response spectra.

The 5% damped target response spectra thus obtained, are used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion are found to be be 0.567 g and 0.414 g, for MCE and 0.322 g and 0.217 g for DBE conditions respectively. The acceleration response spectra for damping ratios of 2%, 3%, 5%, 7%, 10% and 15% of critical are computed from the design accelerograms.



Seismic sources in the region of project site along with the epicenters of available data on past earthquakes



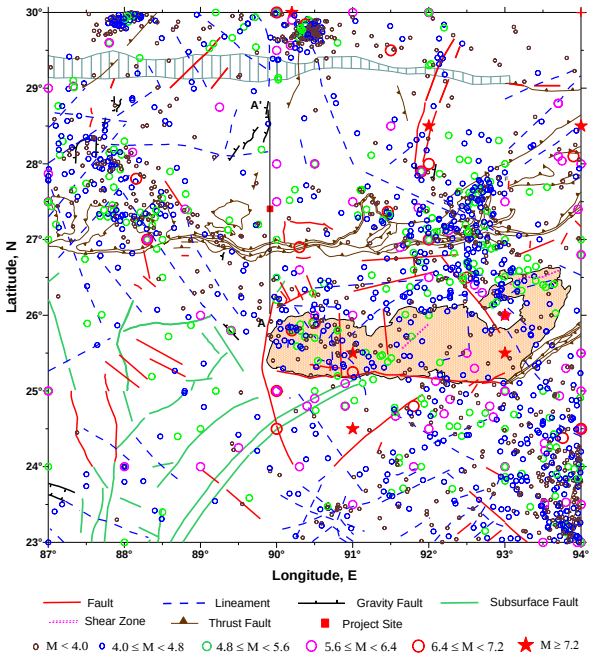
Design response spectra with damping ratios of 2%, 3%, 5%, 10% and 15% critical as computed from the MCE level of accelerograms for horizontal and vertical components of ground motion

5275-ESTIMATION OF SITE-SPECIFIC SEISMIC DESIGN PARAMETERS FOR PUNATSANGCHHU-I HYDRO ELECTRIC PROJECT, BHUTAN

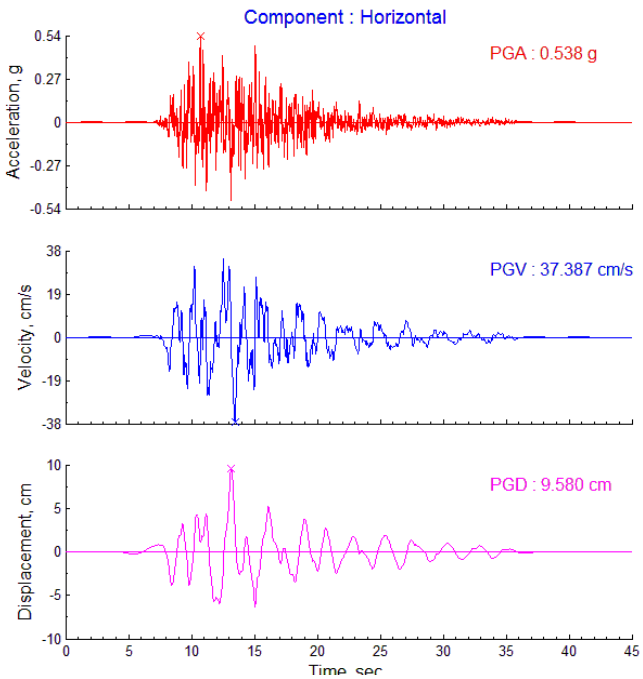
The Punatsangchhu-I Hydro Electric Project in Central Bhutan envisages the construction of a 130 m high and 240 m long concrete gravity dam across river Punatsangchhu. The project site is located in Wandue Phodrang village, at latitude 27º 24′ 21″ N and longitude 89º 54′ 45″ E. The underground powerhouse has an installed capacity of 1200MW. The project site is located in the highly seismic Himalayan tectonic province, which is having complex geological setup.

Using regional data on tectonic features and associated seismicity, along with local geotechnical characteristics, site-specific seismic parameters have been estimated for earthquake resistant design of the various components of the project, using both deterministic and probabilistic approaches. The deterministic estimate is found to be governed by a maximum credible earthquake (MCE) of magnitude 7.5 on the Main Central Thrust at a closest distance to fault rupture plane of 20.5 km. The 5% damped response spectra of horizontal and vertical components, with confidence level of 84% and 50% for this earthquake provide the basic deterministic target spectra for the MCE and DBE levels of ground motion respectively. The probabilistic target spectra for MCE and DBE conditions are computed with return periods of 2500 and 475 years respectively, by estimating the total expected seismicity in terms of the recurrence rate of earthquakes in different magnitude intervals for various seismic sources in the region. Since the difference between deterministic and probabilistic spectral amplitudes, for horizontal component, is less than 25% at the period of interest, for the MCE and DBE levels, the envelope of both the spectra has been taken to be the target response spectra. For the vertical component, as the difference is greater than 25% at the period of interest, for the MCE and DBE levels, the weighted average of both the spectra with equal weights has been taken to be the target response spectra.

The 5% damped target response spectra thus obtained, are used to generate the compatible accelerograms. The values of the peak ground accelerations for horizontal and vertical components of motion are found to be be 0.538 g and 0.376 g, for MCE and 0.316 g and 0.206 g for DBE conditions respectively. The acceleration response spectra for damping ratios of 2%, 3%, 5%, 7%, 10% and 15% of critical are computed from the design accelerograms.



Correlation of the epicenters of past earthquakes with major tectonic features in the region of project site

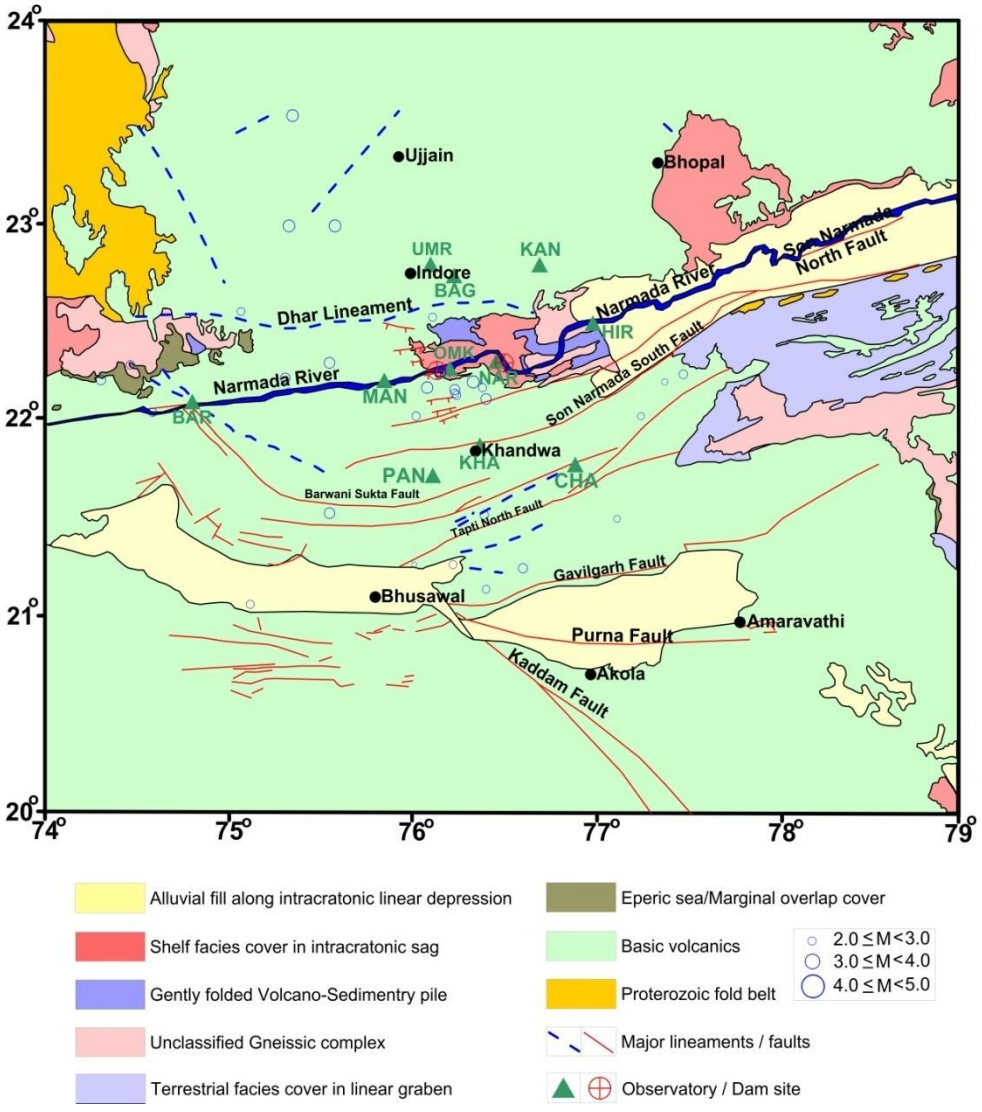


The MCE level of design accelerogram and the computed velocity and displacement records for the horizontal component of ground motion

5279-ANALYSIS AND INTERPRETATION OF SEISMOLOGICAL DATA FOR INDIRA SAGAR PROJECT, MADHYA PRADESH (PERIOD JAN-2010 TO DEC-2012)

The area of Indira Sagar project with 92 m high concrete gravity dam across Narmada River in Khandwa District of Madhya Pradesh forms a part of the peninsular India, which is considered to be seismically stable region. However , low to moderate level of seismicity has been experienced at some isolated locations of the Peninsula. The area of Indira Sagar project forms a part of ENE-WSW trending Son Narmada Tapti (SONATA) tectonic zone which is characterized by low to moderate level of seismicity. To study the possible influence of reservoir impounding on the local seismicity pattern and to monitor the current seismic activity in the area of Indira Sagar projrect, a local network of eleven observatories was deployed. Each observatory is equipped with 1 Hz short period seismometer connected to analog micro earthquake recorder.

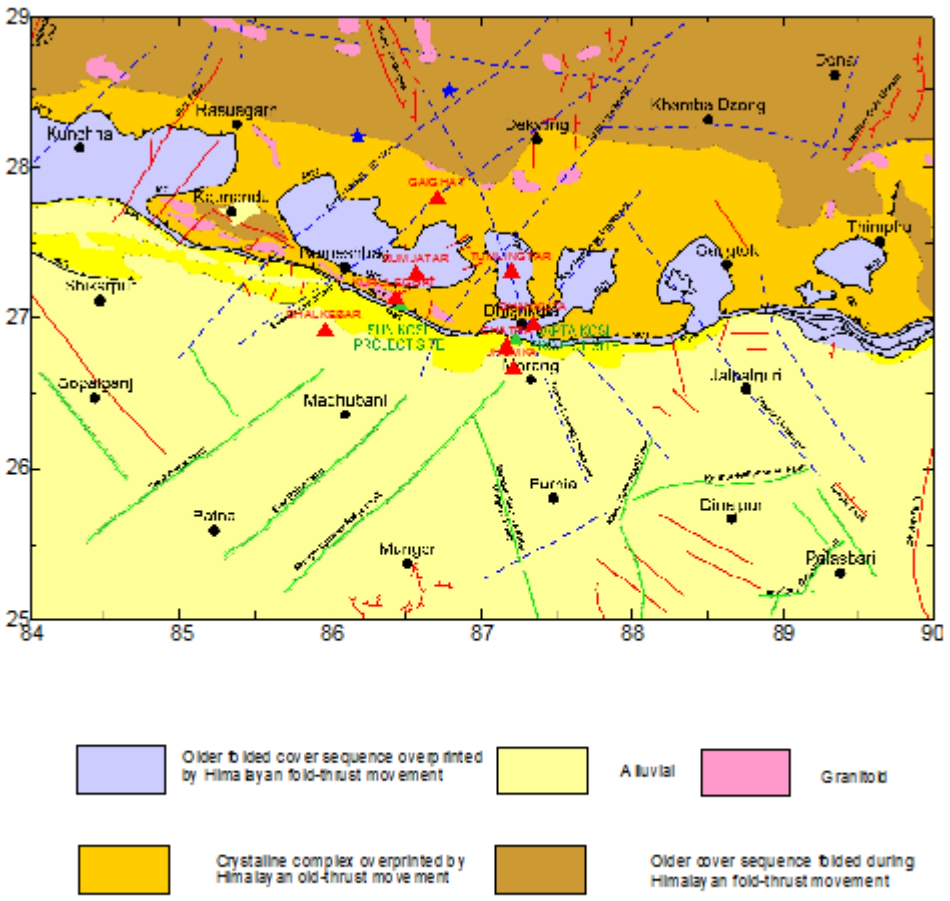
This report presents the analysis of data collected for the period January-2010 to December- 2012 to study the temporal, spatial and magnitude distributions of local seismicity. The total number of local events recorded at the eleven observatories is 572. For 32 events recorded simultaneously at three or more number of stations epicentral locations are obtained which are found to be dispersed all over the SONATA zone except some small concentration of events near Omkareshwar observatory. In general the observed activity does not seem to be spatially associated with the location and extent of the reservoir.



5280-MICROEARTHQUAKE STUDIES AT AND AROUND SAPTA KOSI HIGH DAM MULTIPURPOSE PROJECT AND SUN KOSI STORAGE-CUM-DIVERSION SCHEME, NEPAL

The Sapta Kosi High Dam Multipurpose Project, a 269 m high rock fill dam across river Sapta Kosi in Nepal is located at latitude 26° 53′ 29″ N and longitude 87°10′14″ E. At about 8.0 km downstream of the Sapta Kosi dam, a 969.9 m long barrage is also proposed at latitude 26° 50′ 07″ N and longitude 87° 08′ 41″ E near Chhatra village. The project is located in highly seismic Himalayan region and is in the proximity of major tectonic features, namely Main Boundary Thrust (MBT) and Main Central Thrust (MCT). To evaluate the seismic potential of the various tectonic features at and around the project, a network of eight seismological observatories namely Chatra, Jhumka, Dhankuta, Tumlingtar, Dhalkebar, Gaighat, Kuruleghat and Rumjatar were established in September 2009. A total of 243 events were recorded during the two year period of the study indicating low seismicity in the region. The low seismicity may be mainly due to the lack of data caused by power supply failures and possible hardware failures and therefore is not the indicative of the true local seismicity.

A total of 243 events were recorded at six stations out of eight since two stations were nonfunctional. Out of the 243 events, 188 events have been recorded at 3 stations namely Chatra, Gaighat and Tumlingtar. It is observed that the microearthquakes recorded at Chatra and Gaighat sites originated within a distance range of 200 km and having a magnitude range of 2.0 to 5.0. Results show that the temporal distribution of local seismicity is quite random in nature, and exhibits no definite pattern; this could be due to discontinuous data at these sites.



Major seismotechtonic and geological features, with seismological observatories and located events of Sapta Kosi Sun Kosi investigation project, Nepal

INSTRUMENTATION, CALIBRATION & TESTING FACILITY

5178-EFFICIENCY TEST ON 2 X 4.5 MW TURBINE UNITS AT VEER HYDRO ELECTRICPROJECT, SATARA, MAHARASHTRA

The field efficiency test on 2 X4.5 MW Kaplan turbines of Veer Hydro Electric Project was undertaken during as per the request of the Executive Engineer, Ghatghar Hydro electric Div no. 2, Kalwa, Thane– 400605. This work was undertaken during the span of last one year 2012-13. The prototype turbine tests were carried out to evaluate overall efficiency of the turbine near Full Reservoir level (FRL), and the Minimum Draw Down Level (MDDL). The objective of these field tests was to evaluate present efficiency of turbine unit before undertaking renovation, modernisation and upgradation (RMU) of the plant, on completion of 35 yrs of operation. Accordingly, CWPRS officials conducted the field tests at different water levels during the period of May 2012 to May 2013.

For measurement of turbine outlet discharge, the velocity - area method was adopted. For this purpose Valeport make current meter was deployed in the selected portion of canal section for measurement of water velocity. The average velocity measured by the propeller current meter was multiplied with corresponding section area to get average discharge based on V-A method integrated over entire section selected. The net head on turbine was determined using elevated level of dam and turbine central line. Generator power output values were recorded from panel meter displayed in the control room of the plant.

It was observed during the field tests that the overall efficiency of the turbine T1 at FRL varied from 72.48% to 81.07% for load varying from 1.1 MW to 4.5 MW and for turbine T2 it varies from 71.33% to 78.04% for the same load variation. During the tests at MDDL, overall turbine efficiency for turbine T1 is evaluated 72.13% for a load of 2.55 MW and for turbine T2, it is 69.62% for load 1.8 MW.

From the series of tests carried out, it could be observed that the turbine unit is operating satisfactorily, however, appreciable enhancement in overall efficiency is expected to be achieved for a refurbished turbine. Project authorities may also maintain better hydraulic conditions at Penstock, Runner, Scroll casing and Draft tube by taking up proper repair and refitting. The turbine T2 which has deteriorated more during the span of 35 years of operation is expected to gain in performance after renovation.

5222-ESTIMATION OF RESERVOIR CAPACITY AND SEDIMENTATION OF TAWA RESERVOIR, M.P., USING INTEGRATED BATHYMETRY SURVEY SYSTEM UNDER HYDROLOGY PROJECT-II

Sedimentation in reservoir is one of the prime concerns in today's reducing water resources potential. Also the life span of the reservoir is determined by the rate of sedimentation, which gradually reduces the useful storage capacity of the reservoir. This loss affects the purpose for which the reservoir is constructed. Therefore to optimize the benefits from the project, it is necessary to have knowledge of the likely progressive reduction in storage during planning/ operation stage. To estimate the same methods such as stream flow analysis, Integrated Bathymetry Survey (IBS), Satellite Remote Sensing (SRS), Empherical methods and mathematical models are presently in use.

Among all the methods, Integrated Bathymetric Survey is the only direct measurement method, in which the location and the depth information is directly logged for sediment estimation. However, each methodology has their own advantage as per the site conditions. The IBS system consists of a multichannel GPS system for accurate position fixing, a dual frequency Echo sounder for measuring the live and original depth (inclusive of deposits) and sophisticated data logging and analysis software. Data collection, processing and calculations are done by proven algorithms on processing software. The results are more accurate than any of the conventional survey methods.

The present study was carried out for Tawa Reservoir belonging to Govt of Madhya Pradesh to estimate the reservoir capacity and other parameters such as sedimentation, area elevation etc. The survey was taken up at an elevation of 341.98 m R.L. As the reservoir water-spread area was more around 200 sq.kms at FRL, the contour of the survey area was required for the planning the survey. Accordingly five imageries at different water-levels were shortlisted jointly with the project officials through NRSC website and the same was supplied by NRSC to CWPRS on 10th March 2014. The imagery corresponding to 09 June 2013, corresponding to water level 341.98 m was digitized and the survey planning was done on this contour using NAVISOFT software module.

The objective of the survey is to estimate the sediment volume at this level. The survey boat consists of Echo sounder, GPS system. The Position was acquired with a DGPS reference system to sub-meter accuracy and the depth was measured with dual frequency echo sounder operating at 210 and 33 KHz simultaneously. Sound velocity was calculated based on SVP unit. NAVISOFT software was used for logging the data in dual frequency mode.

Initially the boundary profile was verified by imagery. After confirmation the survey lines were drawn in 100 m grid interval and the data was acquired. The bathymetry data collection was completed during 07-12 March, 2014. The collected data was edited and filtered on SURFER software and analyzed for the area elevation, contour and 3-D profiling with the help of Navisoft and Surfer. The capacity of the lake is 648.75 Million cubic meters at 341.98 m RL, which corresponds to an area of 68.93 Sq.kms. The Original Capacity as per the project authority is 719.49 Million cubic meters, which corresponds to an area of 68.93 Sq.kms. Hence the reduction in capacity is 70.64 M.cum i.e. 9.82% of the original capicty.

5240-ASSESSMENT OF TURBINE EFFICIENCY UNDER DIFFERENT RESERVOIR LEVEL AT KOPILI HYDRO ELECTRIC PROJECT, ASSAM

North Eastern Electric Power Corporation Limited (NEEPCO), the Government of India Enterprise under the Ministry of Power was set up on the 2nd of April, 1976 to plan, investigate, design, construct, generate, operate and to maintain power stations in the North Eastern Region of the country. The work of Research consultancy for assessment of Turbine efficiency under different reservoir levels at Kopili HE Project Assam was assigned to CWPRS, Pune by General Manager (C) R&D, QC&A and SD NEEPCO Ltd. Shillong, Assam. The studies were conducted in two phases in the month of August and December 2014 as the all the seven units have under gone extensive scheduled maintenance on rotational basis since January 2014. The data collection and the hydraulic performance of all the turbine units (4X50MW, 2X25MW & 1X25MW) were carried out at the available reservoir levels of respective power plants.

It was observed during the field tests, all turbine units are operating at close to the reasonable efficiency points as claimed by the turbine manufacturers. But the overall efficiency of the plants is low due to the depletion of reservoir water level in view of the head loss due to the leakages at static and dynamic plant operational conditions. This in turn, decreases the power generation of Kopili (4X50 MW) power units of about 0.489 MW at 16 m^3/sec for single unit and for Kopili Stage II (1X25MW) power unit is 0.336 MW at 32 m^3/sec considering the leakage at static conditions of the conduits. It was found that the loss of net head is compensated by the unit water consumption (per MWh of generated electricity) by the plants during exploitation.

In situ hydraulic tests were recommended to identify, rectify and rehabilitation of the weaker sections of conductor system due to the corrosion thinning of the conduit systems. Further, an Impressed Current Cathodic Protection (ICCP) system is suggested in addition to adequate protective coating for the penstock structural steel sections for the prevention of acidic corrosion. A periodical monitoring, thickness measurement at penstock sections and head loss measurement of the system is recommended.

Site conditions at Kopili HEP due to acidic contamination in the reservoir

2249-FIELD INVESTIGATION TO SUGGEST PROPER FLOW MEASURING INSTALLATIONS AT THE SITE OF HINDALCO INDUSTRIES LIMITED, MURI WORKS, RANCHI

The measurement of flow rate is very significant for effective utilization of available water resources. It is also important to properly determine what metering technology is best suited for custody transfer or process control applications. Initial visit by CWPRS officials to project site, Hindalco Muri in May 2012 revealed that, there is a scope of improvement in the piping layout and metering system of existing installation. Further, on approval of relevant work estimate, a field visit was carried out in June 2014 by officials of CWPRS, Pune. During the field visit, a shift in error of 5-12% is noticed at the existing meters which are installed at various locations of site. The suitable flow meters for the river water applications and the layout for the existing setup is proposed. In addition to that state of art communication with add in features along with technical literatures are also annexed.

Project authorities are requested to incorporate the up-gradation in the existing system with suitable flow meters with add in features as recommended. The metering units may be pre-calibrated at CWPRS before installation at actual site. Terms of condition may be included in the purchase agreement with the supplier of meters accordingly. Secondly CWPRS will carry out the final inspection of metering sections and its accuracy after installations at site.

Existing Water Meters with improper installations at site

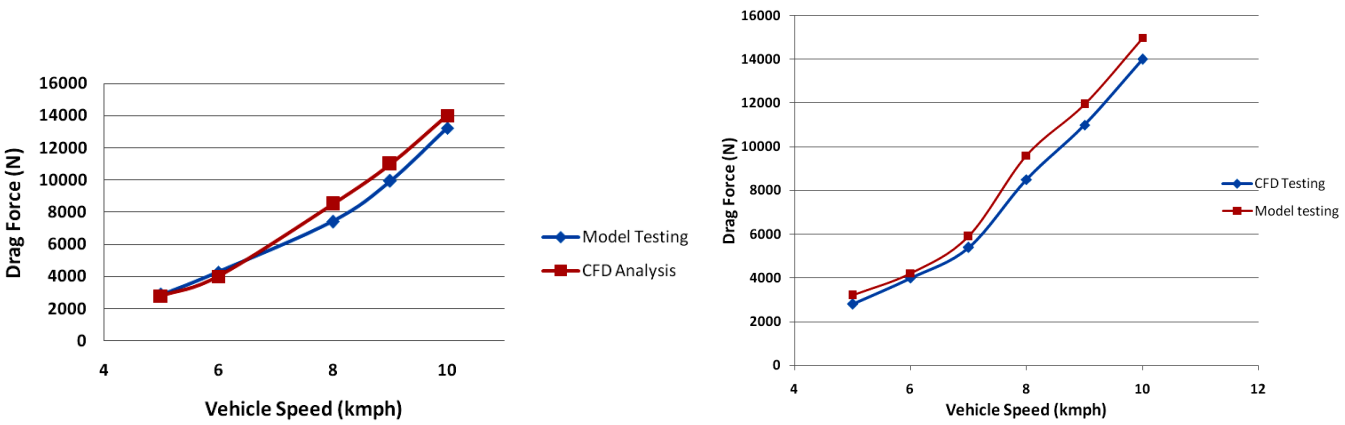
5273-DRAG EVALUATION FOR COMBAT WHEELED VEHICLE MODEL FOR VRDE, AHAMADNAGAR, MAHARASHTRA

Vehicle Research and Development Establishment (VRDE), Ministry of Defence, Govt. of India, Ahamadnagar, Maharashtra has entrusted the study of drag evaluation for combat wheeled vehicle model using Current Meter Rating Trolley (CMRT) facility. The objective of the study is to indigenously design & develop technology demonstrator Wheeled Armoured Platform (WHAP) for variety of combat and combat support role. Combat wheeled vehicle is amphibious up to 22.5 tons weight and designed to provide with hydro jets for propulsion in water. Value of drag is a pre-requisite for selection of suitable hydro jets for which analytical and Computational Fluid Dynamics (CFD) predictions of drag force for the vehicle have to be carried out. To validate these analytical and CFD predictions through WHAP, model testing for drag evaluation using Current Meter Rating Trolley (CMRT) in towing tank is carried out.

VRDE wants to perform drag evaluation test for 1/5th and 1/7th sample models for combat wheeled at the CMRT towing tank facility. As the CMRT moves in forward direction, the model gets backward drag due to relative motion of model and trolley. The model position is adjusted by adding weights manually at different trolley velocity so as to maintain the model in horizontal direction. This weight is proportional to the drag value. It is proposed to carry out a selection of water Jet propulsion system for a maximum of 22.5 T category wheeled vehicle to achieve a speed of 10 Km/hr in water and to negotiate a water current of 4 Km/hr

Comparison of drag force evaluated by laboratory testing on 1/5th and 1/7th scaled model and CFD analysis is plotted in figure. It has been observed that results of both the approach matches well with each other, however a very small difference in drag force evaluation by two approaches as shown in figure.

An amphibious vehicle has to cross the canal or river during transit operations. During the crossing in-addition to drag force vehicle has to overcome the side force also which will be exerted due to the water current. It is necessary to observe the stability of the vehicle in amphibious operations during cross flow. It is very difficult to simulate this kind of scenario experimentally, i.e.,vehicle is moving in one direction and water current is perpendicular to it. Cross flow stability of the vehicle is also checked out by simulating field conditions in model for the various speeds Model testing at various angle i.e.18.5, 26.5, 45.0and 90.0 were carried out and vehicle is found stable. Studies have indicated that design Speed of 10.0 Km/hr and cross current of 4 Km/hr may be achieved by WHAP without flow of water over the top of the hull and vehicle is stable.



Drag results using model testing & CFD a) 1/5th b) 1/7th

PART-III
DISSEMINATION OF INFORMATION

PAPERS PUBLISHED

1. Arora Mukesh, Smt. A.R. Khaladkar "Canal Automation - To Raise Water Use Efficiency", *Seminar on "Reforms in Management of Public Irrigation System",* 30-31 October 2014.

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PARTICIPAPTION IN SEMINARS/ SYMPOSIA/ CONFERENCES/ WORKSHOPS

Sl. No.	Event	Organiser, Date and Place	Name of Officer(s)
1.	Conference on "Flow Measurement in Open Channel & Closed Conduits"	NWA, 13 August 2014, Pune	Abdul Rahiman P.M., Sc-D
2	INDO-JAPAN workshop on "River Mouths, Tidal Flats and Lagoons"	Dept. of Ocean Engg., IIT Chennai, 15-16 September 2014, IIT Chennai	Kudale M.D., Sc-E Ranganath L.R., Sc-D Mahalingaiah A.V., Sc-D
3.	Symposium on "National Instruments (NI) Technical Symposium 2014"	National Instruments, 23 September 2014, Hotel Le Meridien, Pune.	Swami S.R., Sc-C Gupta Lata (Mrs), Sc-B Katte V.N., Sc-B
4.	Seminar on "Reforms in Management of public Irrigation System"	30-31 October 2014, Bangalore.	Arora Mukesh, Sc-C
5.	5th Indian Rock Conference "Underground Construction for Hydropower, Mining & Infrastructure INDOROCK 2014"	CSMRS, 12-14 November 2014, New Delhi.	Ghosh A.K., Sc-D
6.	Three day conference "Jal Manthan"	MoWR RD&GR, New Delhi, 20-21 November 2014	Jagtap R.S., Joint Director
7.	National Level Conference on "Recent Trends in Science and Engineering (NCRTSE-2014)	Dr.D.Y. Patil School of Engineering & Technology, Lohegaon, 12-13 December 2014, Pune	Varshikar N.B., Sc-B Ghodake V.K., Sc-B
8.	Seminar on "Data Analysis made easy using MATLAB"	Mathworks India Pvt. Ltd., 2 December 2014, Pune	Shimpi J.A., Sc-B
9.	HYDRO-2014 19TH International Conference on Hydraulics, Water Resources, Coastal and Environmental Engineering	Maulana Azad National Insitutue of Technology (MANIT), Bhopal, 18-20 December 2014, Bhopal	Kudale M.D., Sc-E Ranganath L.R., Sc-D Neena Isaac (Mrs.), Sc-D Selva Balan M, Sc-D Chaudhari M.S., Sc-C B. Raghuram Singh, Sc-B Malik Kuldeep, Sc-B Vaidya M.M., Sc-B Chaudhari R.K., Sc-B Gadge P. P. (Mrs), Sc-B Kulhare Amit, Sc-B Bharde A.B., RA

			Singh A.K. (Dr), ARO Bagwan A. K. (Dr), ARO Karthikeyan M, RA
10.	Seminar on "Electro-Dynamics, Shakers, Controllers & Environmental Chambers"	AIMIL Ltd., Pune Ramee Grand Hotel, Apte Road I, Shivaji Nagar, Pune-4 16 December 2014	Varshikar N.B. Ghodake V.K. Palei P.K.
11.	3rd National Conference on “Innovations in Mechanical Engineering”	Sinhgad Institute of Technology, Lonavala, 9-10 January 2015	Kumar K (Dr), Sc-B
12.	India Water Week-2015 organised by CWC, MoWR, RD & GR	MoWR, 14-17 January 2015, Pragati Maidan, New Delhi.	Ramesh C. (Dr), Sc-C Solanki Pratap Singh, Sc-B Vivekanandan N., ARO
13.	National Conference (NCRTIT-2015) on “Inter Disciplinary Research on Recent Trends in Information Tchnology and Computer Engineering”	D.Y. Patil College, Nigdi, Pune, 22-23 January 2015	Atkekar N.D., Sc-D

PARTICIPATION IN TRAINING PROGRAMS

Sl. No.	Event	Organizer	Date and Place	Name of officer(s)
1.	ICDP International Workshop on "Probing Reservoir Triggered Earthquakes at Koyna, through Scientific Deep Drilling"	Koyna, Maharashtra	Koyna, Maharashtra, 16-18 May 2014	Kamble R.K., JD Ghosh A.K., JD Krishnaiah C. (Dr), Sc-D
2.	Training on "Structural Monitoring Instrumentation"	AIML Ltd., New Delhi	AIML Ltd., New Delhi, 22-23 May 2014	Kamalasekharan P.D., Sc-C Sonavane Ajay, ARO
3.	Workshop on "Avenues for Research in the Areas of Hydrology, Water Resources and Climate Change Impacts"	SVNIT, Surat	SVNIT, Surat, 5th June 2014	S.Kannan, ARO
4.	Workshop on "Storm Water, Wastewater and Flood Modelling using XPSWMM"	NWA, Pune	NWA, Pune, 4th June 2014	Vijayagopal P., Sc-B Ms. Abha Garg, RA Vaibhav P. Konde, RA Mahesh D. Sawant, RA Vijay D. Kokane, RA Shrikant J. Shinde, RA Mrs. Archana S. Shinde, RA
5.	Training programme on "Fluid Power Society of India (FPSI)	R&DE, Dighi	R&DE (Engineers), Dighi, Pune, 19th June 2014	Goel P.K., Ec-E Yoganath A., JE
6.	One day workshop on "Avenues for Research in the areas of Hydrology, Water Resources and Climate Change Impacts"	SVNIT, Surat	SVNIT, Surat, 14 July 2014	Vivekanandan N., ARO
7.	Training Workshop on "Outcome Budget"	ISTM, New Delhi,	ISTM, New Delhi, 11-12 August 2014	Ranganath L.R., Sc-D
8.	Training programme on "Pay Fixation, ACP & MACP"	INGAF, Mumbai,	INGAF, Mumbai, 20-22 August 2014	Ghodake A.M., UDC Joshi S.D. (Mrs.), UDC Tondare R.B. (Mrs.), UDC Khirid J.D., UDC Bhavsar G.J., LDC
9.	Training course on "Use of Geosynthetics for Water Resources Projects'	CSMRS, New Delhi,	CSMRS, New Delhi,12-13 August 2014	Sonawane N.A., ARO Khot A.D., RA

10.	Global Geosynthetics Summit-Enhancing Application of Geosynthetics in Infrastructure sector	Ahmedabad	5-6 September 2014, Ahmedabad	Edlabadkar J. S. (Mrs), Sc-B
11.	"Management Development programme"	NWA, Pune	NWA, Pune, 8-12 September 2014,	Sinnarkar L.R. (Mrs), PS
12.	Training programme on "River Dynamics and Risk Management with GIS"	NWA, Pune,	NWA, Pune, 15-19 September 2014,	Jhuma Rano (Miss), ARO Archana S. Shinde, RA
13.	Workshop on "Modern Tools and Techniques for Water Resources Assessment and Management"	New Delhi	New Delhi, 16-17 September 2014	Ramesh C.(Dr.), Sc-C
14.	Technology Exchange Programme on "Rock Blasting"	NIT, Surathkal	NIT, Surathkal, 18-20 September 2014,	Ghodake V.K., Sc-B
15.	Training programmes on RFMS for the Responsibility Centers	PMD, Cabinet Secretariat, New Delhi	PMD, Cabinet Secretariat, New Delhi, 22 September 2014	Kulhare Amit, Sc-B
16.	DST sponsored Training Programme on "Integrated Scientific Project Management for Woman Scientist"	Dept. of Science & Technology, Centre for Organization Developmen t, Madhapur, Hyderabad	Dept. of Science & Technology, Centre for Organization Development, Madhapur, Hyderabad, 22-26 September 2014,	Patnaik Sangeeta (Mrs), Sc-B Chaudhari Harsha P.(Mrs), Sc-B
17.	Training course on "Laboratory Assessment of Rock (With Practical Demonstration)"	CSMRS, New Delhi	CSMRS, New Delhi, 24-25 September 2014	Gaurav Kumar Singarkar, RA Pravuram Panda, RA
18.	Training programme on "Remote Sensing and GIS – An overview"	NWA, Pune	NWA, Pune, 7-10 October 2014	Dr.(Mrs) Annapurna Patra, Sc-B
19.	Training Programme on Workshop for Liaison Officer for SC/ST- WLO	ISTM, New Delhi	ISTM, New Delhi, 20-21 October 2014	T Nagendra, Sc-E

20.	Training course on "In-Situ testing in rock mechanics"	CSMRS, New Delhi	CSMRS, New Delhi, 25-26 November 2014	Dr. Santosh Kumar Suragani, Sc-B
21.	Training programme on "Modernisation and capacity enhancement of existing hydroelectric projects"	NWA, Pune	NWA, Pune, 17-21 November 2014	Sundar Lal B.S., Sc-B , K Kumar, Sc-B Swain T.K., Sc-B Ghule S.J., ARO
22.	Training programme on "Remote Sensing and Flood Modelling using GIS"	NWA, Pune	NWA, Pune, 15-24 December 2014	Kamuju Narasaiah, ARO Vivekanandan N., ARO
23.	Training Programme on “Managerial Effectiveness Enhancement Programme (M.E.E.P.)	IMTR, Goa	IMTR, Goa, 19-23 January 2015	Amit Kulhare, Sc-B G.V.R. Murthy, Sc-B
24.	National Workshop on “Continental crust and cover sequence with evolution of Indian Subcontinent”	National Centre for Earth Science Studies, Trivandrum, Kerala	National Centre for Earth Science Studies, Trivandrum, Kerala, 20-21 January 2015	Ajay Kumar P. (Dr), ARO
25.	Procurement Procedures	World Bank Office, Delhi	World Bank Office, Delhi 20 January 2015	Srimant Kumar, Sc-B Sundar Lal B.S, Sc-B
26.	Training programme on "Geotechnical Instrumentation for Hydroelectric Projects"	CSMRS, New Delhi	CSMRS, New Delhi 5-6 February 2015	Bist Mahender Singh, Sc-B
27.	Training programme on Integrated Catchment Modeling (ICMOD-2015)	NIH, Roorkee	NIH, Roorkee 9-13 February 2015	Azharuddin G. Golandaj, RA
28.	ISS Refresher Course on "Environmental Statistics and Natural Resource Accounting"	IIFM, Bhopal	IIFM, Bhopal 23-27 February 2015	Jagtap R.S., Joint Director
29.	Training programme on "AutoCAD Fundamentals	Advance Training Institute, Hyderabad	Advance Training Institute, Hyderabad 23-27 March 2015	S.B. Dhawale, Head. D’man S.B. Apte, Head. D’man S.L. Sutar, D’man-III N.P. Shambhudas, D’man-III N.N. Tambe, D’man-I J.S. Borje, D’man-III C.M. Utage, D’man-III A.B. Bapte, D’man-III S.N. Sarde, D’man-III

COURSES ORGANIZED

Sl. No.	Title	Period
1.	Training Course on "Modern Techniques of Integrated Bathymetry Survey and Data Analysis".	12-13 May 2014
2.	Training Course on "Canal Automation"	20-22 May 2014
3.	Training course on "Coastal Erosion and protection" for the Engineers of Harbour Engineering Dept. Govt. of Maharashtra.	18-20 June 2014
4.	3-Day training programme on "Flood Forecasting Model for Koldam HEP" for NTPC officers.	23-25 June 2014
5.	Training course on "Modelling Techniques in Coastal Engineering".	16-19 September 2014
6.	Training course on "Operational Aspects of Hydropower Plants Structural and Hydraulic Considerations".	09-11 September 2014
7.	Training course on "Canal Automation" for WALAMTRI, Andhra Pradesh & Telangana.	29 September – 01 October 2014
8.	Training Course on "Geophysical Investigations for Civil Engineering Projects".	20-22 January 2015
9.	Training Course on "Modelling and Data Needs for Coastal Engineering Projects"	04 -06 February 2015

INVITED LECTURES DELIVERED

Sl. No.	Title	Event, Place, Date	Name of Officer
1.	Sedimentation in rivers	"Core Area Training - River Management", NWA, Pune 2.06.2014	Neena Isaac (Mrs.), Sc-D
2.	Use of River Morphology and Sediment Analysis Software - Hands on	"Core Area Training - River Management", NWA, Pune, 3.06.2014	Tarudkar P.H. ARO
3.	Erosion Protection, River Training Works	"Core Area Training - River Management", NWA, Pune, 3.06.2014	Patil R.G. (Dr.), Sc-D
4.	Physical model for Rivers Morphology Concepts	"Core Area Training - River Management", NWA, Pune, 4.06.2014	Patil R.G. (Dr.), Sc-D
5.	Water Quality Modelling for Sardar Sarovar Project - A Case Study	"Core Area Training - River Management", NWA, Pune, 18.06.2014	Prabhakar V.M (Dr.), Sc-D
6.	RTI ACT 2005	ITP for AAO, NWA, Pune, 4 August 2014	Jagtap R.S., Joint Director
7.	Model Studies and assessments for designing different components of Water Resources Projects	Training Programme on Preparation of Detailed Project Report for Water Resources Projects, NWA, Pune, 11-22 August 2014	Bhajantri M.R. (Dr.), Sc-D
8.	Seismic studies for feasibility study and DPR for Water Resources Projects	Training Programme on Preparation of Detailed Project Report for Water Resources Projects, NWA, Pune, 11-22 August 2014	Pattanur L.R. (Dr.) (Ms), Sc-C
9.	Minimum Environmental Flow	Training Programme on Preparation of Detailed Project Report for Water Resources Projects, NWA, Pune, 11-22 August 2014	Prabhakar V.M (Dr.), Sc-B
10.	Flow Measurement in Open Channel & Closed Conduits	Conference on "Flow Measurement in Open Channel & Closed Conduits", Pune, 13 August 2014	P. Abdul Rahiman, Sc-D
11.	GPS Applications in Water Resources	Training Programme on "Remote Sensing and GIS – An Overview", NWA, Pune, 08.10.2014	Selva Balan M, Sc-D
12.	Sangh ki rajbhasha neeti evam karyanvayan	Orientation Programme for the newly promoted Assistant Director-II, NWA, Pune, 5.11.2014	Gupta K.K., Sc-C

13.	Importance of Model Studies	Training Programme for newly promoted Assistant Director-I/ Asstt. Executive Engineers of CWC, NWA, Pune, 10-21.11.2014	Patil R.G. (Dr), Sc-D Ranganath L.R., Sc-D
14.	Identify Sustainable and Impact full Watershed Management Techniques	Water Neutrality Conclave, Cummins India Office Campus, Balewadi, Pune, 4.11.2014	Vaidya S.P. (Mrs) (Dr), Sc-D
15.	Stress & stability analysis by finite element method of existing dams for enhancement of hydropower generation	Training Programme for 'Modernisation and Capacity Enhancement of Existing Hydroelectric Projects", NWA, Pune , 17-21.11.2014	Rizwan Ali, Sc-D
16.	Turbine Efficiency studies for modernization & enhancement of existing HEP	Training Programme for 'Modernisation and Capacity Enhancement of Existing Hydroelectric Projects", NWA, Pune , 17-21.11.2014	Goel P.K., Sc-E
17.	Renovation Modernisation & Uprating a Technology Feasible option for tapping Hydro Power Potential	Training Programme for 'Modernisation and Capacity Enhancement of Existing Hydroelectric Projects" , NWA, Pune, 17-21.11.2014	Abdul Rahiman P.M., Sc-D
18.	Broad design aspects of barrage weir and canals	Training programme for newly promoted Assistant Director-1/Asstt Ex. Engineers of CWC, NWA, Pune, 10-21.11.2014	Neena Isaac (Mrs), Sc-D
19.	"Importance of model studies in Dam Design"	Training course on"Capacity Building for the Officals of Government of Bihar on the Advanced Topics of Design" Patna, Bihar, 04.12.2014	Rizwan Ali, Sc-D
20.	Application of FEM in Static and Dynamic Analysis of Dams	Training course on"Capacity Building for the Officals of Government of Bihar on the Advanced Topics of Design" Patna, Bihar, 04.12.2014	Rizwan Ali, Sc-D
21.	GPS Applications in Water Resources	Training program on "Remote sensing and Flood Modeling using GIS', NWA, Pune, 15-24 December 2014	Selva Balan M, Sc-D
22.	Role of CWPRS in Water Resources Development and Management	27th Induction Training Program (ITP) for the new appointees of Central Water Engineering (Group A) Services, NWA, Pune, 11 December 2014	Bhosekar V.V. (Dr.) (Mrs), Sc-E

23.	Broad design aspects of Barrage Weir and Canals	Training programme for newly promoted Assistant Director-II/ Sub Divisional Engineers of CWC, NWA, Pune, 03 December 2014	Neena Isaac (Mrs.), Sc-D
24.	Sangh ki Rajbhasha evam Karyanvayan	Training programme for newly promoted Assistant Director-II/ Sub Divisional Engineers of CWC, NWA, Pune, 04 December 2014	Gupta K.K., Sc-C
25.	Fundamentals of Geophysical methods for subsurface exploration with special emphasis on the GPR techniques	One Week Winter School on "Quaternary (Geoarchaeology) and paleoenvironment, Dept. of Archaeology, Deccan College, Pune, 13 December 2014	Chaudhari M.S., Sc-C
26.	Vigilance Disciplinary Rules	27th Induction Training Programme (ITP) for the new appointees of Central Water Engineering (Group A) service, NWA, Pune, 18 December 2014	Rajendra Aswale, CAO
27.	Right to Information Act 2005	27th Induction Training Programme (ITP) for the new appointees of Central Water Engineering (Group A) service, NWA, Pune, 19 December 2014	Kamble R.K., Sc-E
28.	Sangh ki Rajbhasha evam Karyanvayan	27th Induction Training Programme (ITP) for the new appointees of Central Water Engineering (Group A) service, NWA, Pune, 22 December 2014	Gupta K.K., Sc-C
29.	Introduction of Coastal Engineering and Marine Engineering	Guest Faculty for undergraduate students at AISSMS, Pune, 14 January 2015	T Nagendra, Sc-E
30.	Concrete Technology, additives, admixtures etc	27th Induction Training programme on "Basic Sciences - Hydrology, Hydraulics Structures, Soil and Rock Mechanics", NWA, Pune, 13 January 2015	Pillai S.J., Sc-B
31.	Concrete Technology, additives, admixtures etc	27th Induction Training programme on "Basic Sciences - Hydrology, Hydraulics Structures, Soil and Rock Mechanics", NWA, Pune, 13 January 2015	Patil A.V., Sc-B

32.	Soil Mechanics : Soil Properties (Hydraulic & Mechanical) Permeability & seepage; stress in soils, compaction consolidation etc.	27th Induction Training programme on "Basic Sciences - Hydrology, Hydraulics Structures, Soil and Rock Mechanics", NWA, Pune 14 January 2015	Muralidhar B., Sc-C
33.	"Water Pollution and Remedial Measures"	Celebration of Science Week, at Abeda Inamdar Senior College, Pune, 22 January 2015	Prabhakar V.M (Dr)
34.	Meteorological Data Collection	27th Induction Training Programme on "River Management Training" NWA, 10 February 2015	Ramesh C. (Dr.), Sci-C
35.	Statistical Analysis in Modelling	27th Induction Training Programme on "River Management Training" NWA, 09 February 2015	Jagtap R.S., Joint Director
36.	Physical Model for River Morphology concepts	27th Induction Training Programme on "River Management Training" NWA, 18 February 2015	Patil R.G. (Dr.), Sci-D
37.	Introduction to various Acts on Coastal Management	27th Induction Training Programme on "River Management Training" NWA, 18 February 2015	Manjunatha S.G., Sc-D
38.	Introduction to Coastal Protection Works/Techniques	27th Induction Training Programme on "River Management Training" NWA, 18 February 2015	Kudale M.D., Sc-E
39.	Field Data Requirement for Coastal Protection	27th Induction Training Programme on "River Management Training" NWA, 18 February 2015	Tayade Bhushan R., Sc-B
40.	River behaviour management and training: Types of structures for river training	27th Induction Training Programme on "River Management Training" NWA, 20 February 2015	Patil R.G. (Dr), Sc-D
41.	Design of Canal Automation System	Training programme for officials of Govt. of Bihar on "Design of Weirs, Barrages and Canals" WALMI Patna, 12 February 2015	Arora Mukesh, Sc-C
42.	Seismic Instrumentation	Training Course on "Geotechnical Instrumentation for Hydroelectric Projects" CSMRS, New Delhi, 5-6 Feb 2015	Khupat Sachin N., Sc-B
43.	Introduction of Coastal Engineering and Marine Engineering Projects	Participation as Guest Faculty for undergraduate students at AISSMS College of Engineering, Pune 25 February 2015	T Nagendra, Sc-E

44.	Survey using DGPS	27th Induction Training Programme on "River Management Training: Preparation of Detailed Project Report, Project Investigation and Planning" NWA, 02 March 2015	Selva Balan M, Sc-D
45.	Mass Concrete: Construction Process	27th Induction Training Programme for the newly appointed officers of Central Water Engineering (Group `A') Services NWA, 31 March 2015	Pillai S.G., Sc-B

CONTRIBUTIONS TO BIS AND ISO STANDARDS

ISO Standards Reviewed

1. ISO 4369:1979, Measurement of liquid flow in open channels -- Moving-boat method
2. ISO/TR 9210, Measurement of liquid flow in open channels – Measurement meandering rivers and in streams with unstable boundaries
3. ISO 6416, Hydrometry – Measurement of discharge by the ultrasonic (acoustic) method
4. ISO/TR 11330, Determination of volume of water and water level in lakes and reservoirs
5. NWIP for ISO 13798:2010, Hydrometry – Specification for a reference rain gauge pit
6. ISO/TS 15768: 2000, Measurement of liquid velocity in open channels -- Design, selection and use of electromagnetic current meters
7. ISO 9212:2006 (Ed 2), Hydrometry – Measurement of liquid flow in open channels – Methods of measurement of bed load discharge
8. ISO 26906:2009, Hydrometry – Fish passes at flow measurement structures
9. ISO/PWI 18481, Hydrometry – Open Channel flow measurement using free overfall - End-depth method for estimation of flow
10. ISO TC 113/SC 2/ N 642, Hydrometry - Low cost baffle solution to aid fish passage at crump weir flow measurement structures (Technical Report)
11. ISO 4375: 2000, Cableway systems for the stream gauging
12. NWIP for ISO/TS 24155, Hydrometry – Hydrometric data transmission systems – Specification of system requirements
13. ISO/TS 3716:2006, Hydrometry – Functional requirements and characteristics of suspended sediment samplers
14. ISO 4365:2005, Liquid flow in open channels-sediment in streams and canals- determination of concentration, particle size distribution and relative density
15. ISO/CD 11657, Flow measurement in open channels - Determination of calibration by Surrogate Techniques - Sedimentation in streams and canals
16. ISO 2425:2010 (Ed3) "Hydrometry – Measurement of liquid flow in open channels under tidal condition"
17. ISO 9195:1992 "Liquid flow measurement in open channels-Sampling and analysis of gravel-bed material"
18. ISO/DTR 21044-1"Hydrometry -- Stream gauging – Part 1: Fieldwork".
19. ISO/DTR 21044-2"Hydrometry -- Stream gauging – Part 2: Computation of discharge"

30th group meetings of ISO/TC 113 'Hydrometry' at Tokyo, Japan

The 30th group meetings of ISO/TC 113 'Hydrometry' and its subcommittees were held at the JSCE Headquarters in Tokyo, Japan from 24-29 May 2015. The meetings of working groups were also held during this period. The meetings were attended by the representatives of China, UK, USA, Netherlands, Japan, India and WMO.

S. No.	IS No.	Title
1	IS 1191:2003 I ISO 772:1996	Hydrometric determination – Vocabulary and Symbols (Second Revision)
2	IS 3917:2003 I ISO 4364:1997	Specification for scoop type bed material samplers (first revision)
3	IS 8389:2003	Code of practice for installation and use of rain gauges, recording (second revision)
4	IS 15352:2003/ ISO 6420:1984	Liquid flow measurement in open channels – Position fixing equipment for hydrometric boats
5	IS 15353:2003/ ISO 8333:1985	Liquid flow measurement in open channels by weirs and flumes – V – shaped broad-crested weirs
6	IS 15358:2003/ISO 9196:1992	Liquid flow measurement in open channels – Flow measurement under ice conditions
7	IS 15359:2003/ISO 11329:2001	Liquid flow measurement in open channels – Measurement of suspended sediment transport in tidal channels
8	IS 15360:2003 I ISO 4364:1997	Measurement of liquid flow in open channels – Bed material sampling
9	IS 15362:2003/ ISO 14139:2000	Liquid flow measurement in open channels – Flow measurement in open channels using structures-compound gauging structure
10	IS 15823:2009 I ISO /TR 11627:1998	Hydrometry – Computing stream flow using an unsteady flow mode(based on ISO/TR 11627: 1998)
11	IS 15847:2009 I ISO 9123:2001	Measurement of total discharge in open channels – Stage-fall-discharge relationship (adoption of ISO 9123:2001)
12.	IS 1192:2013	Measurement of liquid flow in open channels using current - meters or floats (second revision)
13.	IS 3910:2013	Hydrometry - Rotating- Element Current-Meters (second revision)
14.	IS 6339:2013	Hydrometry - Sediment in streams and canals -Determination of concentration, particle size distribution and relative density (first revision)
15.	IS 9108:2013	Hydrometry - Open channel flow measurement using thin-plate weirs (first revision)
16.	IS 12752:2013	Hydrometric Determinations - Flow Measurements in Open Channels using Structures - Guidelines for Selection of Structure (first revision)
17.	IS 4410 (Part 11/sec6): 1994	Glossary of terms relating to river valley projects

PARTICIPATION IN MEETINGS OF TECHNICAL COMMITTEES

Sl. No.	Name of Committee	Date and Venue	Participant(s)
1.	30th meeting of the Standing Technical Advisory Committee (STAC) of CSMRS	07 July 2014 CSMRS, New Delhi	Govindan S. Director
2.	Attended 2nd Expert Committee meeting for "Formulation of guidelines for use of Geotextiles, Geobags, Geotubes in construction of flood management works"	12.01.2015 CWC, New Delhi	Shri B. Muralidhar, Sc-C
3.	Attended BIS meeting	27.01.2015 New Delhi	Dr. R.G. Patil, Sc-D
4.	Attended meeting of ISO work related to WRD 3 Sub-Committee 3:1 and WRD 1:1	27.01.2015 BIS, New Delhi	Shri S. Govindan, Director
5.	Attended inaugural ceremony of Water Ex World Expo 2015	29.01.2015 Goregaon, Mumbai	Shri S. Govindan, Director
6.	Attended inaugural ceremony of 3rd India Water Week-2015	12.01.2015 Vigyan Bhawan, New Delhi	Shri S. Govindan, Director
7.	Attended first meeting on Desilting/Dredging the river area near Hathnikund Barrage	05.03.2015 Office of Secretary, Irrigation & WRD, Haryana	Ms. Neena Issac, Sc-D
8.	Attended second meeting on Desilting/Dredging the river area near Hathnikund Barrage	20.03.2015 Office of Secretary, Irrigation & WRD, Haryana	Ms. Neena Issac, Sc-D
9.	Attended meeting regarding Hydrometry Sectional Committee WRD 1	02.03.2015 BIS, New Delhi	Shri S. Govindan, Director

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