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जल संसाधन मंत्रालय

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES

केन्द्रीय जल और विद्युत अनुसंधान शाला

CENTRAL WATER AND POWER RESEARCH STATION

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2004-2005

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CENTRAL WATER & POWER RESEARCH STATION
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FROM DIRECTOR'S DESK

It gives me great pleasure in presenting our Annual Report 2004-2005 highlighting the activities and achievements of the Central Water and Power Research Station. As an apex body in hydraulic research our R&D support is primarily for three major sectors, viz. water resources, power and surface transport. With ten major disciplines under one umbrella, CWPRS has distinct advantage while providing solutions to problems involving multiple disciplines.

During the year 130 new studies were awarded and 126 technical reports on various studies were submitted to the project authorities. Use of fly ash in construction of Roller Compacted Concrete (RCC) dams is not only beneficial but also environment friendly. However, it requires careful optimization of mixes and placement temperatures to avoid thermal cracks. For Ghatgar Pumped Storage Scheme which is the first project using RCC technology in the country, CWPRS made significant contribution by developing new test equipments and software for conducting studies. Intakes forming the critical initial element of water conductor systems require careful hydraulic design to avoid air entrainment, vibrations and cavitation problems during operation. Safe and optimum intake designs were evolved through physical/mathematical model studies for several industrial projects on river Brahmani, Nagaveli and HE projects like Indira Sagar, Kuttiyadi, Mouda. The advice and studies for site-specific design accelerograms and use of dynamic modulus of elasticity of dam concrete were found to be extremely useful by the Koyna project authorities to arrive at a safe and economical design for strengthening the overflow section.

For hydro, thermal and nuclear power projects studies ranged from hydrology, seismology, controlled blasting, geophysical investigations, hydraulic designs of spillway, energy dissipater, desilting basin, dam instrumentation and reservoir sedimentation.

With the increasing public concern about environment, CWPRS was involved in studies such as coastal erosion and beach nourishment, water quality downstream of tailings dam, location of intake/outfall for cooling water for thermal power projects and desalination plants, and disposal of dredged material.

CWPRS, over the years, has made significant contributions in planning and development of major ports and large number of minor ports in the country. CWPRS continued to be associated with the major ports for their expansion and new development plans. CWPRS team visited the tsunami affected areas in Tamilnadu and Andman Nicobar Islands. Number of studies have been undertaken for repairs of the damaged port structures.

The World Water Day was celebrated at CWPRS on 22.03.2005. On this day the Technical Memorandum "unh fu;=.k rduhd" was released at the auspicious hands of the Honourable Minister for Water Resources. Dissemination of knowledge is an important mandate of CWPRS. During the year, training courses were conducted for coastal engineers, practicing engineers, projects officers, designers, planners and investigators.

V.M. Bendre (Mrs)

THE INSTITUTION AND MANAGEMENT

The Central Water and Power Research Station (CWPRS), Pune, as it is known today, was established in 1916 by the then Bombay Presidency as a "Special Irrigation Cell" with a limited mandate to modify irrigation practice to meet agricultural requirements and alter the agricultural methods to meet irrigation limitations. Recognising its role in the systematic study of various phases of water flow including floods, the institution was taken over by the Government of India in 1936.

With the dawn of independence and launching of planned development of the Nation's water resources, CWPRS became the principal central agency to cater to the R&D needs of projects in the fields of water and energy resources development and water-borne transport. Today, as a part of the Union Ministry of Water Resources, CWPRS is increasingly called upon to advise on projects in fields as diverse as river training and flood control, design and stable channels, irrigation and hydroelectric structures, harbours, waterways and coastal protection, structural design, integrity of structures, foundation engineering, utilization of soils, concrete and other construction materials, pumps and turbines, ship hydrodynamics, hydraulic design of bridges, earth sciences, reservoir competency, cooling water intakes, cooling pond efficiency, discharge of industrial effluents, and hydraulic instrumentation.

The current 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 dealing with water resources, power and water-borne transport. Consultancy and advisory services are offered to the government within the sphere of its activities. Disseminating expertise and research findings amongst hydraulic research fraternity, and promoting research activities at other institutions by imparting training to their research manpower, are also undertaken.

The solutions offered by the Research Station are based on the investigations from physical and mathematical models, field investigations coupled with desk studies or from a combination of these. The Research Station also collects prototype data on a variety of engineering, hydraulic and environmental parameters. The requirement of accurate and reliable instrumentation, data acquisition and control systems for physical model studies, prototype measurements are also met with by in-house developments. CWPRS with an interdisciplinary approach in all its activities thus represents unique services available to the country and the ESCAP region. The major clientele of CWPRS include:

- Central Government Departments / Agencies
- State Government Departments / Agencies
- State Research Institutes
- Port Trusts / State Port Organisations
- Public/private sector undertakings
- Municipal Corporations

CWPRS campus, situated at downstream of Khadakwasla dam, near Pune, occupies an area of 180 Ha, where basic services include water re-circulation system for Physical Models, Library, Workshop, an Auditorium and housing facilities. A full-fledged Computer Centre provides necessary infrastructure for Mathematical Modelling work.

The present work at CWPRS covers major disciplines such as :

- Hydrology and Water Resources Analysis
- River Engineering
- Reservoir and Appurtenant Structures
- Coastal and Offshore Engineering
- Ship Hydrodynamics
- Hydraulic Machinery
- Earth Sciences
- Mathematical Modelling
- Foundation and Structures
- Instrumentation & Control Engineering

Organisational Setup

The CWPRS is a subordinate office of the Ministry of Water Resources. Apart from approval for release of funds under various heads, the Ministry of Water Resources administratively controls the functioning of the Institution. A Governing Council, a Technical Advisory Committee and a Budget and Programme Committee render advice to the Ministry regarding functioning of the Research Station.

Governing Council

The Governing Council functions as an overall policy making body under the Chairmanship of the Secretary, Ministry of Water Resources. The Council comprises members from the Finance and Administrative Wings of the Ministry of Water Resources, Planning Commission, User Organisations, State Governments and Non-government Officials. Apart from laying down broad policy guidelines for the Research Station, the Council monitors the overall progress and performance of the institution. Other functions of the Council 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 to the Director.

Technical Advisory Committee

The Technical Advisory Committee, chaired by the Chairman, Central Water Commission, is primarily intended to assist the Governing Council in the matters of research 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 institutions.

Budget and Programme Committee

The Budget and Programme Committee is Chaired by the Director, CWPRS, with Finance Officer, CWPRS as Member-Secretary. The Budget and Programme Committee assists the Governing Council to formulate budget proposals.

Staffing

The total staff strength of the research station is 1600. The Director is the "Head of Department" and Chief Administrative Officer is designated as "Head of Office". The research cadre of about 400 is supported by Technical, Auxiliary Technical, Administration, Accounts and Ancillary services.

Research & Development

WATER RESOURCES DEVELOPMENT

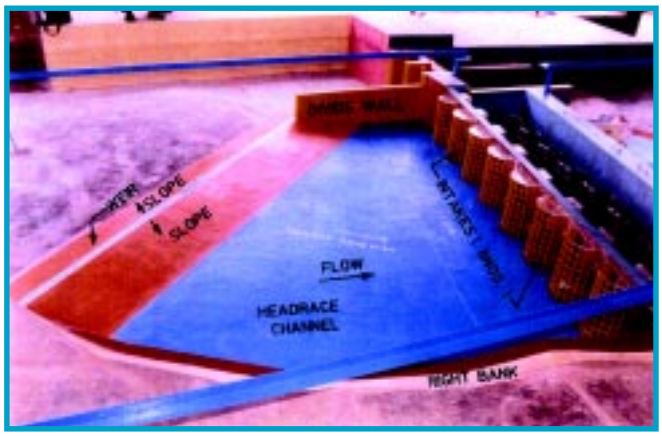
STUDIES REPORTED : WATER RESOURCES DEVELOPMENT PROJECTS

STUDIES FOR OMKARESHWAR DAM SPILLWAY AND POWER INTAKE, MADHYA PRADESH

The Omkareshwar Multipurpose Project is located on the Narmada River near Barwah town in Khandwa District of Madhya Pradesh. It is a run-of-river project 40 km downstream of the Indirasagar dam at Punasa. The project envisages power generation with installed capacity of 520 MW (8 x 65 MW) at river bed power house on the right bank and irrigation of approximately 2,83,300 hectares of land annually. The dam has a total length of 949 m and height of 64.0 m with a 570m long concrete spillway. The spillway consists of 23 spans of 20 m width equipped with radial gates of size 20 m x 18.03 m. The crest of the spillway is at EL. 179.6 m. The spillway is designed to surplus the outflow flood of 88,315 m^3/s corresponding to the probable maximum flood with reservoir water level at EL. 199.62 m. Power intake structure has been proposed on the right bank of the dam. A headrace channel of length 243.2 m with average width of 208m has been provided for 8 penstocks of 7.66 m diameter. A tailrace channel of length 212 m with average width of 242 m is proposed to discharge the water back in to the river. The full reservoir level and minimum draw down level of Omkareshwar Project are EL. 196.6m and EL. 193.54 m respectively. The hydraulic model studies were conducted at CWPRS for the spillway and power intake structures.

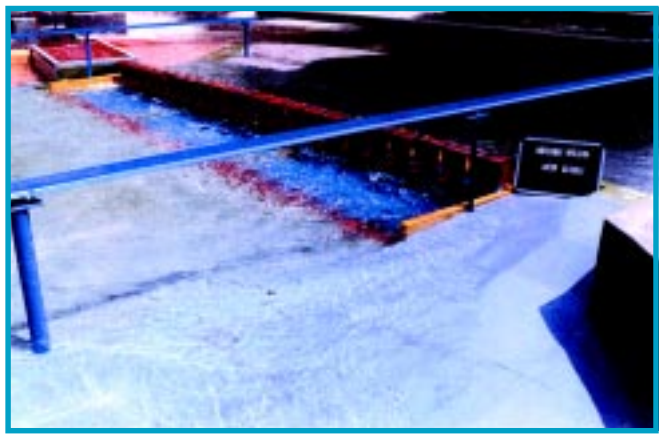
The hydraulic model studies for spillway were conducted on 1:50 scale 2-D sectional model. The studies indicated that the discharging capacity of the spillway would be adequate. The performance of the originally proposed slotted roller bucket as the energy dissipator was not satisfactory for the entire range of discharges. As the discharge intensities and velocities were high, the stilling basin type energy dissipator with the apron at EL. 156 m was considered suitable for this Project. The performance of stilling basin was found to be satisfactory up to 60% of design discharge. It was suggested that a 20 m long solid concrete apron may be laid on fresh rock, properly anchored and keyed at downstream of end sill to protect the stilling basin from undermining.

Hydraulic model studies for spillway and power intake were also conducted on 1:110 scale 3-D



▲ *View of Modified Layout of Headrace Channel*

comprehensive model to study flow conditions, flow distribution and energy dissipation. In addition to original two divide walls provided to segregate the bays in the spillway, two more divide walls were suggested to contain the return eddies. The approach flow was uniform and tranquil without any vortices upstream of the spillway. In head race channel, a cross flow was observed in the channel towards the spillway which might cause deposition of silt near the intakes. The sill of headrace channel was recommended to be



▲*View of Stilling Basin For Q = 88,315 m^3/s*

raised to EL. 180 m and an upstream divide wall of 89m length with top level raised to EL. 196.60 m was suggested between powerhouse and spillway. Water level fluctuations of the order of 0.7 to 1.0 m were observed in the tail race channel when the spillway was operating along with powerhouse. In order to reduce these fluctuations and to prevent the entry of sediment into the tail race channel, it was suggested to extend the right training wall of the spillway. It was also suggested to dress down the ground near the toe of Mandhata Island near tail race channel area and increase the weir length to 280 m with its crest level raised to EL. 160.90 m. These measures were expected to lower the water levels in Kaveri branch and thereby improve the head for power generation.

A 1:60 scale geometrically similar model for power intake structure was constructed to study likely vortex formation at the intake, flow conditions in the head race channel and tail race channel for different combinations of power intake operation. The studies indicated that there was no air entraining vortex formation near the intakes for any possible combinations of intake operation and flow conditions along the head race channel were steady uniform.

It was also observed that the velocity distribution at the weir crest provided at the downstream end of the tail race channel was fairly uniform.

EXTENSION OF GUIDE BUNDS OF PROPOSED ROAD AND RAIL BRIDGES ON KOSI RIVER, NIRMALI, BIHAR

National Highway Authority of India, New Delhi and East Central Railway, Patna, Bihar, have proposed construction of a road bridge and a rail bridge across river Kosi near Nirmali in North Bihar. Earlier, the studies were carried out at CWPRS for finalizing the locations and alignments of the bridges, design of guide bunds and effect of constricted waterway on the existing flood embankments upstream. The maximum afflux was observed to be 1.35 m and its effect was felt over a distance of 8 km upstream. Subsequently, as decided in the Technical Committee meeting, the hydraulic model studies were conducted at CWPRS for extension of upstream guide bunds to the existing flood protection embankments to neutralize the effect of afflux during high floods.

The studies have been carried out on the physical 3-D model of Kosi river, constructed to a horizontal scale of 1/500 and a vertical scale of 1/70. The design discharge of 22,375 m^3/s was considered for the model studies. The suitable alignments and lengths of the right and left afflux bunds were recommended. The length of right side afflux bund was 7950 m and maximum velocity of flow, as observed along this bund was of the order or 0.50 m/s. The length of left side afflux bund was 8325 m and maximum velocity of flow, as observed along this bund was of the order of 0.60 m/s. The top levels of afflux bunds at various locations were worked out by adding free board of 1.5m to the water levels observed at these locations. It was recommended to protect the side slope of the afflux bunds on riverside by providing stone paving and other side of the bund with vegetal cover or turfing.

ESTIMATION OF SITE-SPECIFIC DESIGN SEISMIC PARAMETERS FOR LOWER GOI, KUTNI AND UPPER BEDA PROJECTS IN MADHYA PRADESH

The Lower Goi Project envisages the construction of a 2211 m long earthen dam with a 175 m long concrete spillway across Goi river, a tributary of Narmada river, near Silavad village in Barwani district. The Upper Beda Project envisages the construction of a 2239 m long earthen dam with a 175 m long masonary spillway across Beda river, a tributary of Narmada river, near Nemit village in Bhikangaon Taluka of Khargone district. These two dam sites are located very close to the Barwani-Sukta fault in seismically active Son-Narmada-Tapti (SONATA) tectonic province. The Kutni Project envisages construction of a 30.36 m high 2625 m long composite dam across Kutni river, a tributary of the Ken river, near Khajua village in Chatarpur district. This dam site is located in the Bundelkhand gneissic terrain of Archaean – Proterozoic age, which is bound by the tectonic features associated with very low level of seismicity. The studies were conducted at CWPRS for estimation of the site-specific design seismic parameters for earthquake resistant design of these three projects by a comprehensive seismotectonic evaluation of the regions around the projects. The design parameters were obtained in the form of acceleration time history and the response spectra for several different damping values.

The past seismicity data in the respective project area for a period of about 200 years were correlated with the tectonic features and were also analyzed to estimate the magnitude of maximum credible earthquake (MCE). The MCE was found to be 6.5 for both Lower Goi and Upper Beda Projects, which were assumed to occur at a distance of 2 km from the site for Lower Goi Project and 7 km for Upper Beda Project with a focal depth of 25 km. The MCE for Kutni Project was found to be 6.0 to occur at a distance of 30 km with a focal depth of 15 km. Further, both the regional and the local geological conditions for all the project sites were taken to be of hard rock type. These specifications were used to obtain the 5% damped response spectra of horizontal and vertical components with a confidence level of 0.84, which provided the deterministic estimate of the MCE level of ground motion and were used to generate compatible accelerograms separately for the horizontal and the vertical components of motion, by incorporating physically realistic phase difference between the two components. The smoothed acceleration response spectra were then computed from these accelerograms for damping ratios of 1, 3, 5, 7, 10 and 15 % of critical. The zero period acceleration values which are equivalent to the peak ground acceleration (PGA) for horizontal and vertical components were estimated for these Projects. The MCE level of accelerograms and response spectra were recommended to be used to test the safety of the dam under extreme but rare load condition. The site-specific horizontal (α_h) and vertical (α_v) design seismic coefficients needed to perform the simplified stability analysis were also suggested as follows :

No.	Project	PGA,g	(α_h),g	(α_v),g
1	*Lower Goi*	*0.247*	*0.081*	*0.054*
2	*Upper Beda*	*0.238*	*0.127*	*0.085*
3	*Kutni*	*0.13*	*0.06*	*0.04*

STADIUM COMPLEX ON YAMUNA RIVER BANK ALONG DELHI – NOIDA FLYWAY & ROAD BRIDGE ACROSS DOWNSTREAM OF WAZIRABAD BARRAGE, NEW DELHI

M/s RITES have proposed to construct a road bridge 800 m downstream of Wazirabad barrage in New Delhi. Also, the Delhi Development Authority (DDA), Delhi, has proposed a complex for cricket-football stadium of an area of about 85 hectares on Yamuna river bank surrounded by right approach embankment of Delhi-Noida Toll Bridge and proposed Kalindi bypass (NH 24), New Delhi. The studies were undertaken at CWPRS to examine the feasibility of these proposals from hydraulic point of view. Studies were undertaken on the existing mobile bed model of river Yamuna at Delhi (scales : 1/300 H & 1/60 V) covering the river reach of 29 km upstream and 21 km downstream of ISBT bridge. Studies were carried out under existing conditions and with proposed developments in position with three discharges namely 7,022 m^3/s, 9,910 m^3/s and 12,750 m^3/s corresponding to a maximum discharge observed in 1988 at Wazirabad barrage, the design discharge and check flood suggested by the Central Water Commission.

Studies indicated that the proposed waterway of 570 m between the abutments would be adequate and the afflux due to the proposed bridge at 800 m downstream of Wazirabad barrage would be negligible. However, in order to improve the flow conditions and to distribute the flow more uniformly along the bridge axis, 350 m long guide bund making 110º angle with bridge axis on the left upstream side and 190 m long guide bund on the left downstream side were recommended. On the right side, no guide bund was recommended. Water level, maximum velocity and maximum discharge intensity along the proposed bridge axis were also estimated for different discharges. The proposed bridge would not cause any undesirable flow conditions at Wazirabad barrage. Thus, the location of the bridge axis 800 m downstream of the Wazirabad barrage (at existing Pontoon bridge axis) was hydraulically satisfactory.

▲ *Model View of Flow Pattern with Proposed Road Bridge For Q = 7022 m^3/s*

The model studies were undertaken for the proposed cricket – football stadium under existing conditions and with the bund (closing the gap between downstream right guide bund of Noida Toll Bridge and proposed Kalindi bypass road) position with different discharges. Existing river bed levels in the vicinity of the proposed stadium vary from RL 202.00 to 203.00 m. The depth of the water varies from 1.75 m to 2.75 m in the vicinity of the proposed site for the proposed stadium with the river discharge of 7,022 m^3/s. As per the model studies, the water level observed in the vicinity of the proposed stadium was RL 205.25 m with bund and RL 205.15 m without bund, corresponding to river discharge of 12,750 m^3/s. It was recommended that the proposed location of the stadium would be hydraulically suitable only after raising the entire area (approximately 85 ha) by 1.0 m above HFL (RL 205.00 m) along with proper drainage arrangement.

RIVER TRAINING WORKS FOR RIVER GANDAK AT DUMARIA GHAT, BIHAR

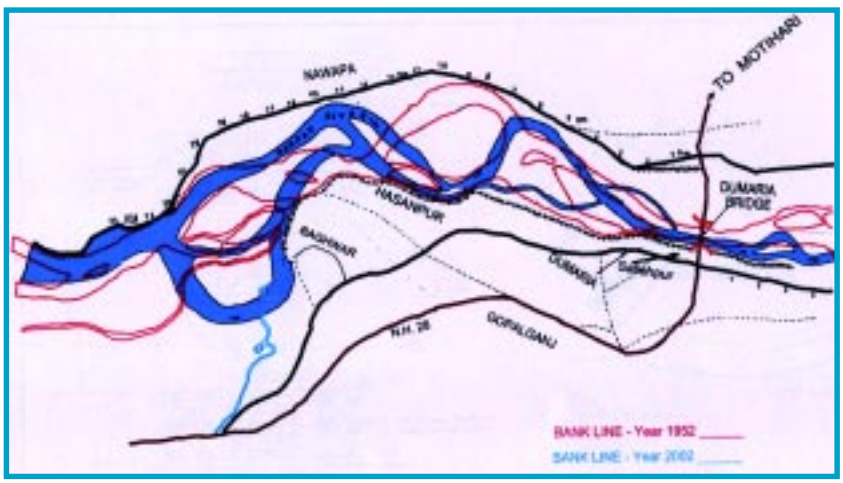
A road bridge has been constructed on river Gandak at Dumaria. The waterway of Dumaria Bridge is 843m having 13 spans of 61 m each and end spans of 25 m. The river Gandak has a channel width of about 250 m during lean period. Village Sallehpur is located close to the right guide bund of Dumaria Bridge and village Hasanpur, further upstream on right bank at a distance of about 6 km from the bridge. The concentration of flow of river Gandak at Dumaria Road Bridge has been observed to be shifting to the right bank in a width of about 250 m covering 2-3 spans of Dumaria Bridge. During the floods of the year 2002, as concentration of flow was towards the right bank, high pressure of flow was observed on the embankments at Hasanpur and Sallehpur and damage to the embankments and bank erosion were observed at these places. On the other hand, the large shoal of height 2.5 m to 3.0 m on the remaining left side spans of Dumaria Bridge was more or less inactive even during high floods.

CWPRS was requested to suggest anti-erosion measures for the eroding bank and to evolve long-term solution to shift the active channel away from the affected right bank. Before undertaking detailed model studies, the site inspection was carried out by CWPRS officials.

The observations made during the inspection and analysis of the available data indicated that the river training measures could be evolved in three stages, namely; "immediate" to provide protection to the eroding bank, "short-term" to initiate shifting of channels away from the right bank to the desired position, and "long-term" solutions to stabilise the channels in the upstream reach so that the problem may not re-occur. With the limited available data, the "immediate" and some of the preliminary "short-term" training measures were suggested.

Anti-erosion measures were suggested in the form of semi-permeable spurs made up of bamboo porcupines at the affected bank, as "Immediate" measure. Excavation of pilot channel within the dead channel flowing along the right bank in the reach 7 km to 3 km upstream of Dumaria bridge and construction of semi-permeable screens across the existing active channel were suggested. It was felt that the re-activation of old course would help to relieve pressure on the right bank upstream of the bridge. The re-activation could also help to reduce the erosion between 8 km and 11 km upstream due to reduction in the discharge of the attacking channel.

The detailed morphological investigations and hydraulic model studies would be necessary to evolve the further "short-term" and "long-term" measures.



Plan of River Gandak at Dumaria Ghat

IRRIGATION BYE- PASS TUNNEL FOR SARDAR SAROVAR PROJECT, GUJARAT

The Sardar Sarovar Project is located at 5.63 km upstream of Navagam village in Bharuch District of Gujarat. The project comprises a concrete gravity dam 1210 m long and 155 m high across the river Narmada. The project provides for a riverbed underground powerhouse of 1200 MW with 6 units of 200 MW each and also a canal head powerhouse with 5 units of 50 MW each. Two irrigation bye-pass tunnels (IBPT), each of 5.50 m dia. have been provided on the right bank of the river to pass water into Pond of canal head power house which would further bifurcate into two tunnels of 2.6 m x 3.9 m size at its exit. The total length of the tunnels, including bifurcation, would be 241.23 m. These tunnels were provided for supply of irrigation flows to Gujarat and Rajasthan to meet their irrigation requirements, especially during peak withdrawl for irrigation and to bye pass the flows to facilitate maintenance of turbines of canal head powerhouse. Each irrigation tunnel was designed to discharge 316 m^3/s for reservoir water level at EL. 138.68 m (FRL) and downstream maximum pond level of EL. 95.10 m. The studies were carried out at CWPRS for assessing the discharging capacity of IBPT and hydraulic downpull and uplift forces on the emergency gate using the 1: 25 scale geometrically similar model.

The energy dissipation arrangement downstream of each IBPT tunnel would be provided with independent stilling basins, each of 72.88 m length and 18.8 m width with an apron. Water from stilling basins would be discharged into downstream pond whose minimum and maximum water levels correspond to EL. 92.96 m and 95.10 m respectively. The water from pond No.1 would then lead to the Narmada canal through a series of interconnected ponds. Fixed wheel emergency gate of size 4.32 m x 5.50 m is provided in each tunnel at distance of about 58.7 m from its entrance. Two vertical slide type service gates of size 2.6 m x 3.9 m are provided at the exit of each tunnel bifurcation.

The discharging capacity of the irrigation bye-pass tunnel was measured for various reservoir water levels between EL. 88.39 m and EL.124 m and the rating curve was suggested for IBPT canal before bifurcation. The model studies on emergency gate, for water level corresponding to EL.110.64 m (MDDL), EL.116 m, EL.124 m and EL.138.68 (FRL) for assessing the hydrodynamic downpull or uplift forces indicated that the emergency gate would experience maximum net hydrodynamic down pull force of the order of 28 tonnes, 30 tonnes, 32 tonnes and 40 tonnes respectively at about 75 % gate opening and maximum net uplift force of the order of 22 tonnes, 25 tonnes, 28 tonnes and 39 tonnes respectively at about 3% gate opening for above reservoir water levels. The net uplift and downpull forces would be considered to decide hoist capacity and the self weight of the gate for self closure.

Model View of Flow in the Stilling Basin for RWL 110.64M & TWL 92.07M (Both service gates fully open)

ESTIMATION OF DESIGN PARAMETERS OF NMC SYPHONS ON RIVER BANAS, KHARI-II AND SARASWATI, GUJARAT

Sardar Sarovar is prestigious multipurpose project across river Narmada to cater the requirements of about 18,75,000 ha in Gujarat and Rajasthan states. Narmada Main Canal (NMC) with design discharge of 1133 m^3/s at the head regulator, traverses through Gujarat state and crosses many rivers including Mahi, Sabarmati, Meghana, Watrak, Banas, Khari-II and Saraswati. The rivers Banas, Khari-II and Saraswati flow through the state of Gujarat and dissipate into Little Rann of Kutchh. The general topography of the rivers is very flat and water enters flood plains even under normal floods. The shifting of channels is noticed in Banas River during the past decades. No gauging site is located on any of the rivers within the study area. M/s Sardar Sarovar Narmada Nirman Ltd. (SSNNL) faced difficulty in computing high flood levels in these three rivers due to flat terrain, large water spread and braiding pattern. The waterways of the rivers Banas, Khari II and Saraswati were finalized during the 38th meeting of Board of Consultants, wherein representatives from CWPRS, IRI Roorkee and SSNNL were present. It was also decided in the meeting that there would be only one structure across Totana arm of Banas river. The studies for estimation of design parameters of syphons at rivers Banas, Khari -II and Saraswati crossing with NMC were carried out at CWPRS for different combinations of guide bund, afflux bunds and marginal bund.

The studies were conducted for estimation of water level, peak flood and velocity at NMC crossing during the passage of Probable Maximum Flood (PMF) and Standard Project Flood (SPF). The present studies were carried out using 1-D mathematical model (NETWORK) and the Topographic data of the river etc. The parameters like spacing and alignment of bunds for river Banas were supplied by SSNNL. The results for river Banas were reviewed and details like spacing of afflux bund for rivers Khari-II and Saraswati were derived.

The studies have been carried out in three stages. In the first phase, sensitivity analysis for spacing of marginal bunds was carried out. In the second phase, flows with straight guide and afflux bunds were simulated for Banas-Khari-II system using different combinations of SPF and PMF. The studies were carried out under existing conditions and lowering the bed to reproduce the desired scour. In the third phase, unsteady flow simulations were carried out to estimate design parameters viz. water level, velocity at NMC crossing for PMF, SPF and 100 year floods for elliptical guide bunds and afflux bunds with flaring. The values of parameters to be adopted in the river training and bank protection works as well as deciding top of NMC embankment at crossing were recommended as given below :

Design parameter	Banas river	Khari-II river	Saraswati river
Waterway taken (m)	700.00	500.00	600.00
Maximum Water Level in river at NMC (m)	55.25	55.72	59.47
Corresponding Velocity in river (m/s)	4.64	3.88	4.64
Water Level behind Bund (m)	57.78	57.50	62.20

A minimum freeboard of 1.0 m above maximum water level was recommended for the bund level of NMC.

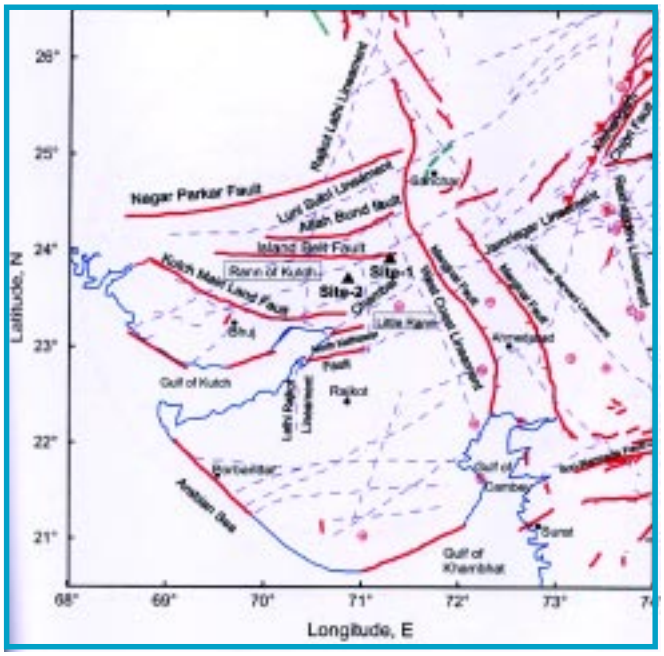
ESTIMATION OF SITE-SPECIFIC DESIGN PARAMETERS AND LIQUEFACTION POTENTIAL OF KUTCH BRANCH CANAL, GUJARAT

To exploit the full potential for irrigation and power generation of the Narmada River Basin (NRB), it is proposed to construct 30 major, 135 medium and about 3000 minor dams along the main river as well as on its tributaries. The Sardar Sarovar Project (SSP) in Gujarat would be the terminal dam of this chain. In addition to the generation of 1450 MW of power, the SSP envisages a large irrigation canal system consisting of the Narmada Main Canal, branch canals, distributaries, minors and subminors. The length of Narmada Main Canal would be about 468 km with discharging capacity of about 1134 m^3/s at its head. There will be in all 42 branch canals off-taking the Narmada Main Canal, out of which Kutch Branch Canal (KBC) is one of the major branches.

▲ *Site Plan of Kutch Branch Canal*

The Kutch Branch Canal (KBC) off taking from Ch. 385.814 km of Main Canal is a major branch canal having total length of 352 km with 170 m^3/s discharge capacity. The KBC would lie in the Kutch area of Gujarat, which is characterized by high level of seismicity. The entire area is traversed by several E-W trending active faults, such as Kathiawar, Kutch Mainland, Island Belt and Allah Bund faults. The region is known to have experienced many large and moderate earthquakes in the past. The proposed canal would be passing through the Bhuj area, which has been the seat of M7.7 earthquake of 26 January 2001. The seismic safety of the KBC is therefore very important. The major length of this canal is in the seismic zone V and the foundation strata mainly consist of silty fine sand / sandy silt which are susceptible to liquefaction failure due to earthquake. The studies were carried out at CWPRS to assess site specific design seismic parameters for earthquake resistant design of earthen embankments of KBC and liquefaction potential assessment of the foundation strata of this canal.

The past earthquake data, geological and tectonic features in the region were analyzed. For this purpose, two critical sites have been identified where the canal has the maximum filling (designated as Site-1) and where it has the maximum cutting (designated as Site-2). In view of large separation between these two sites, the design ground motion was estimated separately. To estimate the design ground motion, both the deterministic and the probabilistic approaches were adopted in the study. The deterministic approach is based on the specifications of a Maximum Credible Earthquake (MCE) whereas the probabilistic approach takes into account the effects of total expected seisimicity in the area around the site of interest. To obtain the design response spectra, a suitable



▲ *Major Tectonic Features in Region of Kutch Branch Canal*

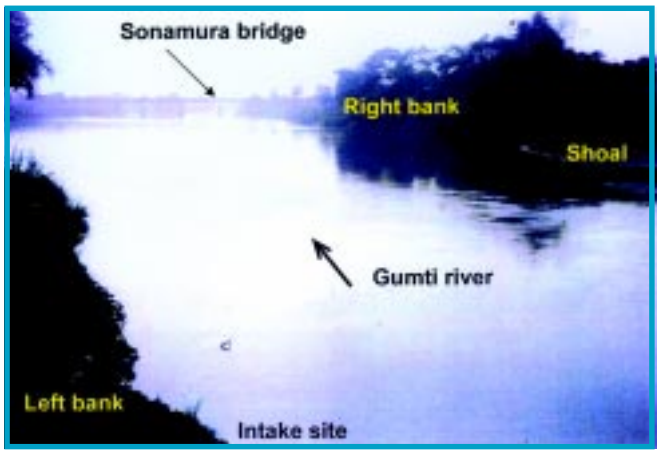
frequency-dependent attenuation relationship was identified from the published literature, using the available ground-motion data from the main Bhuj earthquake and nine of its major aftershocks. The deterministic design response spectra were found to be higher than the corresponding probabilistic one, and hence the same were recommended in view of the safety of the canal embankments. Design accelerograms compatible with these spectra were generated using random phases. The acceleration response spectra for different damping ratios, as obtained from the design accelerograms, were also found for carrying out simplified response analysis of the canal embankments.

Liquefaction analysis for the foundation strata of the KBC portion from 20.0 km to 112.5 km was carried out using the Simplified method as proposed by Seed & Idriss. In this method, Cyclic Stress Ratio (CSR) induced in the foundation soil due to the peak ground acceleration (PGA) is compared depth-wise with the Cyclic Resistance Ratio (CRR) which is computed from SPT values. The earthquake magnitude of 7.8 with PGA of 0.344 g was considered in the present analysis. The analysis indicated that some regions along alignment of canal are susceptible to liquefaction for an earthquake of magnitude 7.8 with maximum depth of liquefaction of 12.0 m below ground level in Rann of Kachch (at CH.86.0 km).

INTAKE WELL AND DESILTING BASIN FOR TRIPURA GAS BASED POWER PROJECT AT MONARCHAK, TRIPURA

The North Eastern Electric Power Company (NEEPCO) has proposed to install a 280 MW gas based power project near Sonamura town about 65 km south - west of Agartala, Tripura. The generation capacity would be increased to 500 MW in the 2nd stage. The make-up water requirement for ultimate generation would be 0.31 m^3/s which was proposed to be drawn from Gumti river located at about 5 km from plant site. On the basis of the site inspection and discussions, the desk studies for various aspects as below were carried out at CWPRS :

- Deciding location of intake and its hydraulic design including necessary protection works
- Examining necessity of desilting basin, its location and design
- Detailed design of pump – sump and pumping system including pipeline.



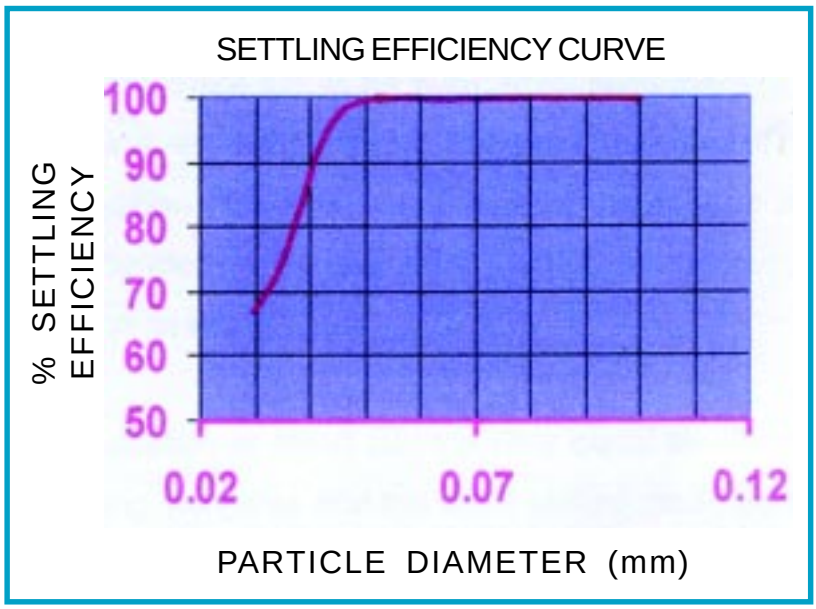
▲ *Downstream view of Gumti River from Proposed Intake Site*

The intake location was finalized at about 700 m upstream of bridge at Sonamura. The deep channel of the river was close to the left bank and had remained there for last 20 - 30 years and ,moreover, at this location, the river bank was relatively steep and stable. The minimum flow of the order of 2.80 m^3/s in river Gumti was observed with corresponding water level of 8.35m at the intake site with river bed level as about 7.20 m. For maximum observed flow of 993 m^3/s in August 1983, the corresponding water level was 14.65m. Based on gauge - discharge curve developed from observed data, the water level corresponding to 100 year return period flood (1320 m^3/s) and design discharge of 2468 m^3/s adopted for Sonamura bridge have been estimated as 15.20m and 15.60 m respectively. Analysis of sediment data indicated high sediment concentration between 1500 ppm to 4700 ppm during flood period extending over 3 - 11 days. The coarse and medium sediment would be about 30% which was required to be minimized from pump operation and maintenance considerations. Considering this, an open intake with a provision of 10m long low level weir with crest at 0.50 m below minimum water level and 12 x 10m silt trap with sill level of 4.0 m below minimum water level was recommended. Bank protection works for a distance of 30 m upstream and 10m downstream comprising wooden piles / steel piles for toe protection and stones in crate laid over synthetic filter for slope protection was suggested. Considering various aspects such as high bank levels, ease of construction and removal of deposited sediment and operation and maintenance of pumps and pipeline etc., the desilting basin was proposed to be located at the plant site.

Two units of desilting basin with one stand-by were proposed. One unit would be in operation while the other could be cleaned/maintained. As manual removal of settled sediment was proposed, no discharge was required to be pumped for flushing of the settled sediment. Twin type desilting basin, having each unit 30.0 m long and 3.0m wide, was designed for 90% settlement of sediment having diameter 0.10 mm and above with inlet discharge of about 0.32 m^3 /sec. This size was adequate for more than 90% settlement of suspended sediment coarser than 0.10 mm. After due consideration of various aspects and frequency of clearing the basin, the Project Authorities were of the opinion that the frequency of

cleaning the basin should be reduced by providing large trap capacity basins.

With the maximum monthly average inlet concentration of 1.918 gms / litre and 60% (assumed) overall settling efficiency of the desilting basin, about 681 cum of sediment would settle in the desilting basin during a month's period. The alternative proposal of the desilting basin consisted of an inlet tank 3 m wide x 3 m long to accommodate two inlet pipes, grid wall, 2.00 m wide channel followed by 1 m channel leading to each unit of desilting basin, control gate, 20 m long inlet transition, 20 m long x 9 m wide basin, and a weir directly discharging into the Raw Water Reservoir. The depth of the trench was recommended to be 2.30 m at the beginning varying to 2.70 m in the length of 32 m, thus, providing about 660 cum capacity to accommodate settled sediment which was adequate. The overall settling efficiency of this proposal was estimated analytically, using Camp's criteria, which worked out to be 79.60 %.



STUDIES ON CONCRETE MIXES FOR STRENGTHENING OF OVERFLOW SECTION OF KOYNA DAM, MAHARASHTRA

The Koyna dam, a multipurpose project for irrigation and hydroelectric power generation, is 103 m high and 807.7 m long across river Koyna, in the Satara District of Maharashtra State. Strengthening of the overflow sections of the dam comprising block nos. 18 to 24 to augment present storage capacity of dam by 1.5 meters and also as a precautionary measure against earthquake, has been taken up by the project authorities. The project authorities planned to complete the strengthening work in two working seasons. The strengthening work comprised placing of concrete in two stages - strengthening concrete and closure concrete. The strengthening concrete was being placed leaving a gap of 1.22 m from face of old main dam. Concrete would be placed in lift height of 1.5 m and lift interval of 72 hrs. The closure concrete in the gap of 1.22 m was placed 30 days after the strengthening concrete from the consideration of shrinkage and thermal effect. In such mass concrete structures, estimation of suitable placement temperature on the basis of thermal, strength and elastic properties, to limit the maximum temperature rise to avoid cracking, is important. The estimated placement temperature of concrete mix is generally below the average ambient temperature. Hence the concrete mix is required to be precooled. Further in the case of such strengthening works where closure concrete is placed subsequently to join strengthening concrete with old concrete, it is also ensured that the tensile stresses due to shrinkage of strengthening concrete are minimized as far as possible within scheduled time (30 days in this case). This minimizes probability of separation at the interfaces of adjoining concrete. The shrinkage (tensile) stresses can be minimized by postcooling the concrete mass at a faster but restricted rate (0.15^{O}C per hour). This is achieved by embedding cooling pipe meshes between each lift and circulating cold water through these pipes at predetermined temperature and at predetermined rate of flow. The studies were undertaken at CWPRS to determine the thermal properties, strength and elastic properties of strengthening concrete and closure concrete, to suggest the suitable placement temperature and cooling arrangements.

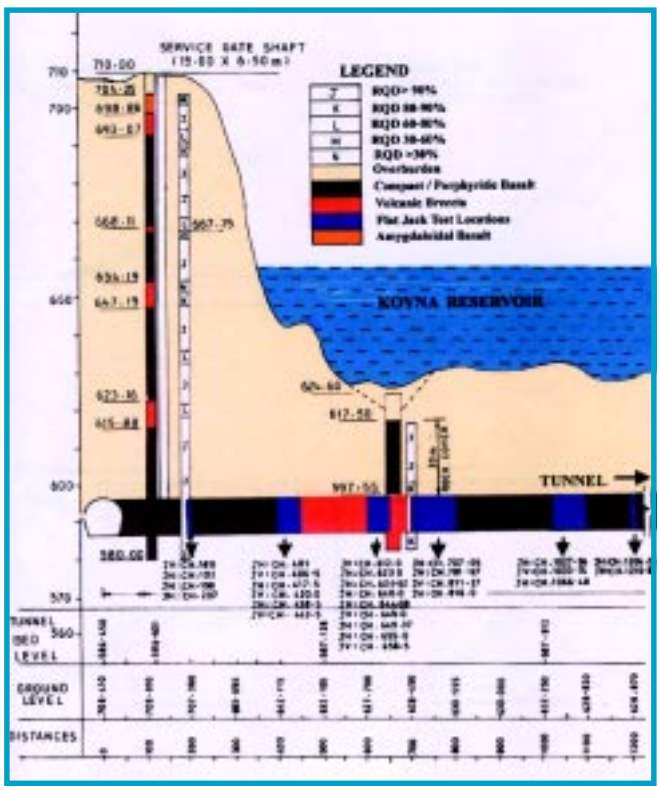
The cement level of strengthening and closure concrete were 177 kg/cum and 200 kg/cum respectively. The laboratory studies indicated 90 days compressive strength of 458 and 495 kg/cm^2, flexural strength of 49 and 50.3 kg/cm^2, specific creep of 2.32 x 10^{-6} and 2.80 x 10^{-6} mm/mm/kg/cm^2 and ultimate strain capacity of 226 x 10^{-6} and 250 x 10^{-6} respectively. The thermal properties of concrete mixes for strengthening and closure concrete indicated adiabatic temperature rise of 26.6^{0}C and 29.9^{0}C, diffusivity of 0.0027 m^2/hr. coefficient of thermal expansion 7.59 x 10^{-6} and 7.61 x 10^{-6} mm/mm/^{0}C respectively. On the basis of the computations, the suitable placement temperatures were estimated to be 18^{0}C to 20^{0}C for the strengthening concrete and 16^{0}C to 18^{0}C for closure concrete. In order to cool and to minimize the stresses due to shrinkage, postcooling of strengthening and closure concrete was suggested. For this purpose, GI pipe mesh of 25 mm diameter at the bottom of first lift and interface of each lift was placed. It was recommended to circulate cold water at temperature of about 22 ^{0}C for a period of 25 to 30 days through the pipe mesh. The pre-cooling and postcooling respectively helped to restrict the temperature rise and to lower the temperature of concrete mass within desired period.

MEASUREMENT OF IN-SITU STRESSES AND DEFORMABILITY OF ROCK MASS IN ADDITIONAL SURGE GALLERY & EXTENSION OF HEAD RACE TUNNEL SECTION OF KOYNA DAM, MAHARASHTRA

In order to achieve optimum utilization of water from Koyna reservoir, it was proposed to lower the intake level of state-IV by 12 meters to obtain an additional supply of 15 tmc of water. The proposed scheme included construction of an additional Surge Gallery of size 75 m(L) x 20 m(W) x 35 m(H), as well as 4.5 km long Horse Shoe shaped Head Race Tunnel, Intake Structure Complex and Lake Tapping.

CWPRS undertook field studies to determine in-situ rock mass properties for effective design of tunnel supports. The rock mass met with at the test locations at Additional Surge Gallery was very good quality Compact Basalt. The depth of overburden in the 9.5 m diameter horse shoe shaped HRT was found to vary considerably ranging between 30 m to 115 m.The rock mass varieties met with at Flat Jack Test locations at extended H.R.T. were mainly Porphyritic as well as massive and jointed varieties of Compact Basalt and very soft to moderately soft varieties of Volcanic Breccia. The Flat Jack Method (BIS 13946 (Part IV),1994), was employed to measure the deformability of rockmass as well as in-situ stresses at 4 locations at the Additional Surge Gallery and 70 locations at the extended Head Race Tunnel.

The method consisted of cutting a thin slot in the rock surface by drilling a series of overlapping holes to relieve the rock of the original stresses. Because of the stress relief, sides of a slot converged. The convergence of the slot was measured between two reference points fixed at a known distance on either sides of the slot prior to cutting of the slot. The Flat Jack was then embedded tightly in the slot and later pressurized by means of hydraulic pump to neutralize the convergence. This pressure at neutralization, termed as cancellation pressure was then corrected to account for the influence of the slot size, reference pins position and the stress acting parallel to the major axis of the slot, so as to obtain induced stresses acting perpendicular to the slot. A number of loading and unloading cycles at each test location resulted in computing modulus of deformability of in-situ rock mass as well as plotting of stress-deformation envelopes. After knowing the induced stresses, the stress concentration factors at the tested elevations based on the excavated shape at the section and unit loading in vertical and horizontal directions respectively were obtained by using 2D Stress Analysis Software package *Examine*^{2D} and in turn in-situ Vertical Stress (s_V) and Horizontal Stress (s_H) were evaluated. On basis of these results, the lining design for the entire HRT was done by the project authority. Based on rock mass varieties at different sections as well as amount of available rock cover, various types of supports comprising of rockbolts, shotcrete, PCC and RCC linings of thicknesses varying from 40 cm to 55 cm were adopted.



▲ *Flat Jack Test Locations at Excavated Section of Extended Head Race Tunnel*

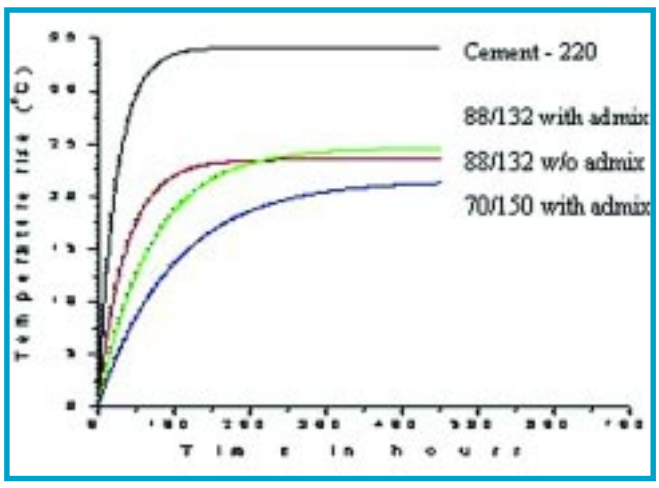
STUDIES ON ROLLER COMPACTED CONCRETE MIX FOR GHATGHAR PUMPED STORAGE SCHEME, MAHARASHTRA

Ghatghar Pumped Storage Scheme comprises Upper and Lower Reservoirs of gross storage 5.87 Million-cum and 3.87 Million-cum respectively. The upper reservoir was created by constructing 14.5 m high and 478 m long upper dam and two saddles. The lower reservoir is created by constructing 84 m high and 415 m long lower dam. The two reservoirs have a head difference of 420 metres. Both the dams are roller compacted concrete (RCC) dams. RCC technique is being adopted for first time in India for dam construction. The studies were conducted at CWPRS to determine thermal properties of the RCC mixes and estimation of suitable placement temperature.

▲ *Construction of Lower DAM*

Initially thermal properties of the three concrete mixes with different cement to fly ash ratio were evaluated. On the basis of these studies, a final RCC mix with cement to fly ash ratio of 88:132 was adopted for use in construction of dams. Thus in the final mix 60% of cement component was replaced by fly ash. The properties of final RCC mix were then used to compute the suitable placement temperature for 0.3 m lift height and 24 hours lift interval. For ease of rolling of concrete and for ensuring adequate bonding between layers of RCC, the setting time of RCC mix was delayed by increasing dosage of admixture (1% by weight of cement + fly ash). Delaying setting time lowers rate of gain of strength and rate of adiabatic temperature rise. To accommodate the effect of retarder, the temperature monitoring of the RCC mixes had to be continued for a period of 30 to 40 days.

The adiabatic calorimeter developed at CWPRS was used for the studies. Its temperature controller was modified for measuring and controlling small change in rate of temperature rise. The calorimeter was further insulated by additional insulation to avoid heat loss during the course of 30-40 days of measurement of temperature. The effect of long term measurement, addition of fly ash and retarder were evaluated. The studies helped in estimating the effect of fly ash and retarder in reduction and rate of temperature rise. The results of the tests were used as input parameters to compute the maximum temperature rise, suitable placement temperature and pre-cooling requirement. In house developed computer program was used for analysis.



▲ *Adiabatic Temperature Rise Curves*

THIRD PARTY PERFORMANCE GUARANTEE PUMP TESTS FOR JANAI (I&II) & SHIRSAI LIFT IRRIGATION SCHEME, MAHARASHTRA

Janai Shirsai Lift Irrigation Scheme is located in Daund Taluka near Patas in Maharashtra. The intake sump receives water from Khadakwasla Irrigation Canal. Janai project has three stage pumping to irrigate land admeasuring 13,835 hectares. The Maharashtra Krishna Valley Development Corporation (MKVDC) has executed the Scheme and it is in the final stage of completion. The subject scheme uses 7 Vertical Turbine (VT) pumpsets rated for 525 kW power, 0.920 m^3/sec discharge and 48.9 m head for Janai Stage I. Similarly, for Janai Stage II, there are 7 VT pump sets rated for 658 kW power, 0.820 m^3/sec discharge and 69.77 m head and a third set of 8 VT pumpsets rated for 446 kW power, 0.495 m^3/sec discharge and 78.06 m head at Shirsai Pump house. The contractual clause for the said installations stipulated that the contractors should carryout performance guarantee tests as per provisions of IS 9137 in presence of a third party expert agency. CWPRS participated in the tests conducted on all the 22 pump sets, as the expert third party neutral agency calibrated the ultrasonic flowmeter which was used during tests. The site tests were conducted with duly calibrated instruments such as tachometer, thermometer, vibration meter, voltmeter, ammeter, frequency meter and wattmeters, etc. to verify the performance behaviour of the pumps in terms of the following:

- Pump head and efficiency against discharge
- Motor power variation against discharge
- Comparison of the results obtained against those guaranteed by the contractors

During the course of tests, it was observed that sizeable quantity of silt had deposited around the suction pipes in the intake well, resulting in unfavourable hydraulic conditions on the suction end of the pumpsets. The project authorities on recommendations of CWPRS made elaborate arrangements to get the sump cleaned thoroughly at Shirsai pump house. This provided better flow conditions on the suction side for the pump tests. It was recommended that this aspect be taken care of during routine operation of these pumpsets in future. Head developed by the pump was measured by digital/Bourdon pressure gauge calibrated against dead weight tester. Discharge was measured by deploying ultrasonic flowmeter. Hydraulic power delivered by the pump was found out from the product of head and discharge. Electrical power input to the motor was measured through the wattmeters. Overall efficiency was calculated from the ratio of hydraulic power delivered to the electrical power input. Bowl efficiency was computed after making due allowances for losses in bearings and line shafts.

The data recorded during the tests was at available mains frequency which was monitored from the instruments fitted on the control panels on these pump houses. The observed results were scaled to 50 Hz. It was ensured that all the measuring instruments, selected for conducting performance guarantee tests were having better accuracy than the limits specified in IS 9137. The discharge measuring section was selected at a distance of 5 times the pipe diameter (D) from the pump delivery flange and the head measuring section was located at 3 D from delivery flange. This ensured that the required velocity profile at these sections is fully developed for accurate measurements.

During the tests the discharge was varied using the throttle valves on the delivery side and every time readings of discharge, head, power, speed, mains frequency, current, voltage etc. were taken. Thereafter the pump performance characteristics in terms of head-discharge, power- discharge and efficiency- discharge were plotted. Crucial performance parameters like efficiency at duty point, guarantee factor-to show how closely the pump met the specified duty conditions, power at duty point etc. were calculated and the findings were furnished to the Project Authorities.

- All the pumps tested were found to have satisfactory and consistent head-discharge characteristic
- All the pumps tested met the condition of having guarantee factor greater than 1, which indicated that the pumps satisfactorily met the specified head and discharge
- All the pumps met the guaranteed efficiency

The tests helped MKVDC to ensure that the supplied pumps did meet the stipulated performance specifications.

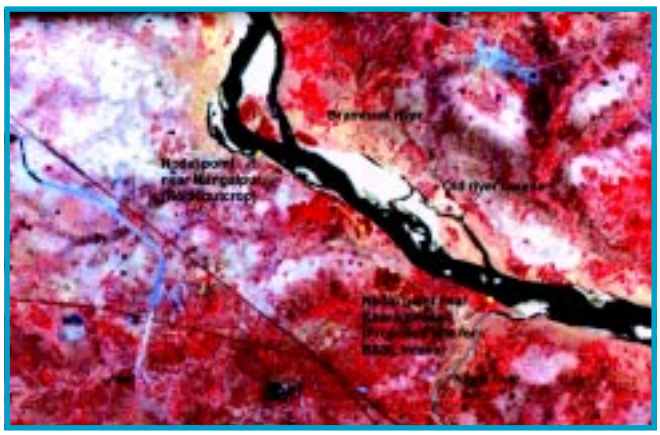
NUCLEAR DENSITY LOGGING FOR MEASUREMENT OF IN SITU BULK DENSITY OF MASONRY AT DUDHGANGA DAM, MAHARASHTRA

The 73 m high Dudhganga Masonry dam was constructed in the year 1989, across river Dudhganga, a tributary of river Krishna in Kolhapur district of Maharashtra. The main purpose of the dam is for irrigation but it also has a powerhouse to generate electricity of 24 MW. Excessive leakage was noticed in the drainage gallery and it increased with the rise in reservoir level. Maximum total leakage measured in the drainage gallery as well as from the downstream face of the dam was about 350 lps. In view of the excessive leakage from the dam, an expert committee was set up to study safety of the dam which suggested the measurement of density of masonry. Accordingly, the CWPRS team carried out Nuclear logging in the three Nx size boreholes drilled in the masonry to depths of 26 m to 40 m in monoliths 5, 6 & 7. Caliper logging was also carried out for identifying gaps / voids present in the masonry. The results of the studies indicated that the bulk density of masonry in general varied from 2.27 g/cc to 2.52 g/cc. The density of masonry below 2.3 g/cc was attributed to the presence of gaps / voids created by leaching of cement mortar material due to excessive leakage. It was recommended to undertake tracer studies to delineate the path of seepage through the body of the dam.

RAW WATER INTAKE FOR BHUSHAN STEEL AND STRIPS LIMITED ON RIVER BRAHMNI, ORISSA

Bhushan Steel & Strips Ltd. (BSSL) a leading producer of cold rolled sheets and galvanized sheets had proposed to set up large integrated steel plant at Meramandali town in Angul district of Orissa at about 120 km North West of Bhubaneshwar. A 600 MW coal fired captive power plant is also a part of the project. The total requirement of water has been estimated to be about 2.89 m^3/s which would be drawn from river Brahmni at about 5 km from plant site. Studies were conducted at CWPRS for deciding the appropriate location and hydraulic design of intake for assured water supply with minimum operational and maintenance problems.

The satellite imageries, toposheets and river cross-sections were studied and the analysis of available prototype data was carried out for finding minimum flow, minimum water level, maximum flow and corresponding HFL, bed and bank material properties. From the study of satellite imageries of different years, it was observed that the Mangalpur and Kharagprasad ghat are the two locations along Brahmani river where the deep channel is always close to the right bank. The right bank near Mangalpur or Kharagprasad ghat was found suitable. However, the location near Kharagprasad ghat has advantages that the river flows in a single channel and the deep channel is hugging the right bank.



▲ *Satellite Imagery of Brahmni River Reach Near Mangalpur*

The Kharagprasad Ghat is being used as a ferry point over the years as seen from 1930 toposheets. Moreover, the right bank is relatively stable and the local inquiry supports the fact that the deep channel has never left this location. Therefore, the intake location at about 130m downstream of Kharagprasad ghat was recommended for BSSL plant.

From the analysis of flow data and measurements during the site visit in May 2004, it was estimated that the water level corresponding to minimum flow of 40 m^3/s gives a depth of flow of 1.50 m in the deep channel. A 30 m long weir along the right bank with crest at about 0.50 m above river bed followed by a silt trap and a pump - sump have been recommended. Considering the minimum depth of flow of 1.50 m available in deep channel, the sill level of pump-sump has been proposed at 2 m below minimum water level so as to satisfy submergence requirement. Necessary bank and toe protection in the form of stones in crates and synthetic filter below were also recommended for a distance of 50m upstream and 20 m downstream of the intake.

INTAKE WELL OF PAPER MILL OF J.K. CORPORATION LTD. IN RIVER NAGAVELI AT JAKAYPUR, ORISSA

The paper mill of J.K. Corporation Ltd. is situated in Rayagada district of Orissa State. An intake well for drawing water for the mill is located in river Nagaveli near right bank. The intake well was commissioned in 1962 to draw raw water of 10 mgd for 18000 TPA capacity. The functioning of intake well with regard to drawl and availability of water was satisfactory till 1982. The Singpur nalla joins at about 250m upstream of existing intake with its entry facing upstream of Nagaveli river. This nalla experiences flash flood with very high sediment load which gets deposited in the river near the right bank and therefore the flow gets deflected towards the left causing erosion of the left bank. The erosion continued in a reach of about 300m. Due to morphological changes in the river over the years, the major flow during lean season concentrated on left side and the right bank where the intake was located, remained dry and the Project Authorities at the paper mill of J.K. Corporation Ltd. were facing problem of non-availability of water at intake. Various temporary measures such as construction of stone barrier, sand bund along the left bank were being adopted by Project Authorities to meet required quantity of water. Further, studies were undertaken at CWPRS to suggest remedial measures for ensuring the availability of required quantity of water at intake particularly during lean season. As a part of the studies, CWPRS Officers inspected the intake site and detailed desk studies were carried out subsequently.

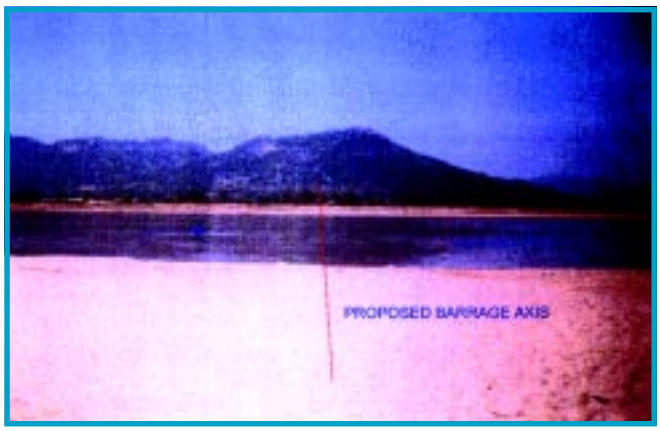
During the site inspection, Project Authorities informed that heavy silting was experienced at the intake during floods. Frequent dredging was also necessary during lean season for maintaining required depth of water. Based on site inspection, CWPRS suggested short term and long-term solutions for the existing problems. A short-term measure of construction of porcupines in the reach of active erosion on the left bank was suggested based on site inspection, data made available and past experience. It was indicated by the Project Authorities that part implementation of short-term measure resulted in improvement of flow conditions near intake. Various long-term measures were examined with the available data. These included pilot channel, construction of weir, realignment of entry of Singpur nalla with Nagaveli river, diversion of Singpur nalla downstream of intake and re-location of the intake at the nodal point upstream of nalla. Considering the merits and demerits of these alternatives, it was considered that locating intake in the river upstream of the confluence of Singpur nalla in the bend along the outer curve would be a permanent long-term solution. Re-locating the intake would ensure the availability of required quantity of water even during lean season and would not pose any serious operational and maintenance problems as were being experienced presently. However, an open intake on the bank with low-level weir at the entry followed by silt trap would be a better alternative from the point of view of siltation problems. It was recommended that until the long-term measures were implemented at the proposed site, short-term measures of streamlining of entry of Singpur nalla along with provision of porcupines on the left bank be continued and river behavior in the reach be monitored.

NERADI BARRAGE ON RIVER VAMSADHRARA, ANDHRA PRADESH

The river Vamsadhara flows through the lower reaches of the states of Andhra Pradesh and Orissa. A Barrage is proposed to be constructed across this river at Neradi village of Srikakulam District, Andhra Pradesh. Canals are also proposed on both the banks of the river to cater for irrigation. The barrage would consist of total 36 bays of which 30 numbers would be spillway bays having a clear width of 18.29 m. The four number of under sluice bays on right bank and 2 under sluice bays on left bank having a clear width of 12.19 m were also proposed.

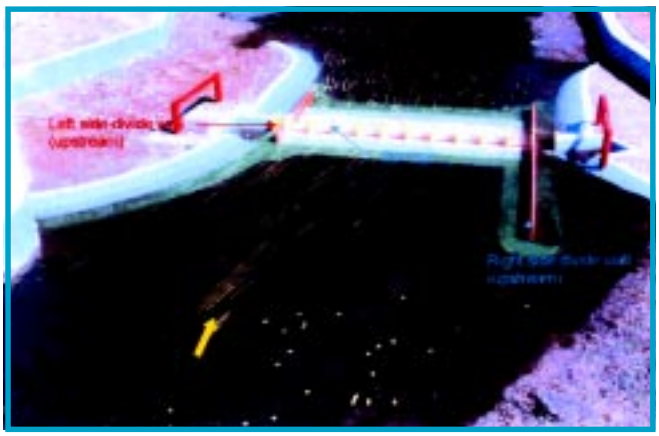
The studies were conducted at CWPRS for estimation of backwater effects and examination of sufficiency of upstream protection arrangements by using physical model (scales – 1/200 H, 1/40 V) and 1-D mathematical model HEC-6. The studies were carried out for four discharges 1000 m^3/s, 2832 m^3/s, 5663 m^3/s and observed maximum 16990 m^3/s. The studies revealed for discharge equivalent to 16,990 m^3/s that:

- Back water length after the construction of Neradi Barrage would be of the order of 6 km upstream of barrage



▲ *View Near the Proposed Barrage Axis*

- Increase in water level at cross section No.2 i.e., 2 km upstream of barrage over the existing condition was observed as 0.72 m
- The rise in water level at cross section No.6 i.e. 6 km was of the order of 0.16 m. However, the rise in water level diminished rapidly beyond this cross section
- With barrage in position, the maximum velocity was observed as 6.17 m/s along the cross section of barrage. Upstream protection measures i.e., concrete blocks and loose boulder protection were therefore, designed accordingly
- Left and right guide bunds were designed as per BIS Code of Practice to ensure streamline flow through barrage



▲ *Flow Pattern with Barrage in Position For Q = 2832 m^3/s*

SHEAR STRENGTH PARAMETERS OF FOUNDATION ROCKMASS FOR UPPER TUNGA PROJECT, KARNATAKA

A 26.2 m high and 770 m long composite dam is under construction across river Tunga at about 100m downstream of the existing Anicut at Gajanur village of Shimoga district, Karnataka. The dam consists of 15.20 m high and 117.50 m long earthen dam with central puddle core at the left flank, a Power block of 52 m length to generate 19.5 MW power, non-overflow sections of 18.50 m length on the left flank and of 126 m length on the right flank. A 321.50 m long high co-efficient weir type concrete Spillway is at the central portion with 22 numbers of radial crest gates of size 11.75 m x 4.74 m to discharge design flood of 7362.40 m^3/s. The field and laboratory studies were conducted by CWPRS to determine the in-situ shear strength parameters and other engineering properties for foundation-rock interface at the downstream of Spillway block nos. I4,18 and 20. These data would be utilized as input data for estimation of dam safety since the foundation rock mass is schist.

The general rock mass forming the dam foundation consists of good quality granites with occasional schistose zone. The foundation rockmass, exposed as outcrop was found to be fresh and hard rock of Schistose variety. In-situ shear tests were carried out on six concrete blocks of sizes 60cm x 70cm casted on foundation rock. For each block, the test procedure involved applying a pre-determined normal stress on the test block and then applying shear stress in small increments till the failure of the block. All six blocks were tested under different normal load conditions to evaluate the shear strength parameters for the dam-foundation interface. The study of failure surface from the upturned views of the blocks revealed that out of six blocks, only two blocks failed along the contact whereas the others failed mostly through rocks and partly through contact. The estimated values of shear strength parameters of the rock blocks i.e. cohesion (c) and friction angle (ϕ) were found to be 10 kg/cm^2 and 59° respectively.

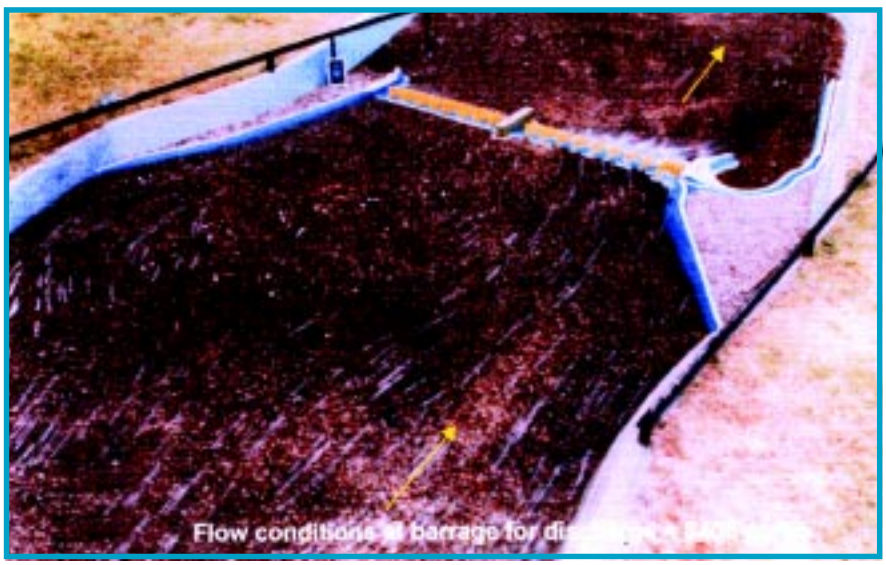
Laboratory studies were conducted on four rock core samples collected from project site representing the foundation rock mass to determine various other engineering properties. The values of properties such as Density, Specific Gravity, % Water Absorption, Static Modulus of Elasticity, Poisson's ratio, Unconfined Compressive Strength and Hardness were found to be varying between 2.75 to 2.85 gm/cc, 2.81 to 2.93, 0.10 to 0.43, 6.58 x 10^5 kg/cm^2 to 8.90x 10^5 kg/cm^2, 0.16 to 0.24, 215 kg/cm^2 to 632 kg/cm^2 and 14 to 33 respectively.

View of Upper Tunga Dam Site

STUDIES FOR UJH RIVER LEVEL CROSSING, JAMMU & KASHMIR

The Ravi canal project in Jammu and Kashmir is the largest irrigation scheme in the Jammu area. The Ravi canal takes-off from the right bank of the river just downstream of the tailrace of powerhouse of the Thein dam project. The 82 km Ravi canal enroute crosses a number of major, medium and minor streams including Ujh river. Ujh river originates from high altitude hills in Tehsil Billawar and Ramnagar of district Udampur and Kathua in J&K state. The Ujh river is a sub-mountainous river which is shallow, wide and has a braided channel pattern. The river is having steep slopes of the order of about 1:150 at the level crossing with riverbed consists mostly of shingles and boulders. The Ujh barrage constructed at level crossing was commissioned in 1980 with a waterway of about 356 m for augmenting of Ravi canal flow. The existing Ujh river barrage level crossing has 18 bays of 16m span with pier thickness of 1.75m for spillway part and 3 spans of 8m, 8m and 16m for undersluice portion. The barrage was designed for a discharge of 5000 m^3/s. In 1987, a high flood of 8835 m^3/s was experienced which resulted in extensive damage to barrage and its appurtenant works. The design discharge was therefore revised by Central Water Commission to 8400 m^3/s. Since the existing waterway of 356 m for the barrage was inadequate to pass the revised design discharge of 8400 m^3/s, it was proposed to extend the waterway of barrage by about 322 m on the left side. Model studies (scales : 1/200 H, 1/70V) were conducted at CWPRS to study various hydraulic issues such as adequacy of waterway, protection works, flow conditions, energy dissipation arrangements etc. with proposed extension of barrage waterway.

The model studies were carried out with extended waterway and re-laid bed as per the fresh survey. It was expected that with proposed extension of waterway of 322 m on the left side, the overall flow conditions and discharge distribution would improve for the revised design discharge. However, the studies indicated that due to cross slope and steep longitudinal slope, the concentration of flow was towards right at the undersluice and adjoining spillway portion and discharge distribution at the revised design discharge was seen to be 75% and 25% through existing and extended waterway respectively. It was therefore, concluded that there was no significant improvement in the overall flow conditions and discharge distribution with the proposed extension of waterway. From the studies, it was inferred that there is a scope for reduction in the total waterway and further studies would be required for optimization in the length of proposed extension of waterway.



Flow Conditions at Barrage For $Q = 8400\ m^3/s$

HYDRAULIC PERFORMANCE AND OVERLOAD TESTS FOR SUBMERSIBLE PUMP SETS

Under the Choudhari Charansingh Pariyojana, the Uttar Pradesh Irrigation Department (UIPD) undertook procurement and installation of large quantities of submersible pumps to tap the ground water potential for purposes of irrigation. The procurement is done on the basis of competitive bidding. One of the important clauses included in the tender enquiry while inviting bids was to get sample designs of these submersible pump sets tested as per testing procedure contained in IS 9137 for their hydraulic performance as well as the performance of their associated motors at CWPRS. Such tests would enable UPID to verify the specific performance guarantees quoted by the bidders in their offer against those achieved in the actual tests conducted by a neutral laboratory. CWPRS conducted following performance tests on ten samples of these pumpsets rated for 21 m and 42 m head with 100 cum/hr discharge.

- Determination of hydraulic performance characteristics viz. variation of head, power input and overall efficiency against discharge covering a minimum range of + 10 % to -25 % of rated head from guaranteed duty point for the 21m head and 42 m head pumpsets

- Conducting over voltage and under voltage tests at 456 volts and 353 volts respectively

- Determination of temperature rise of the submersible motor, when the pump is overloaded to 32 % of its rated capacity

- Analysis of the experimental results by scaling the pump motor performance to 50 Hz mains frequency and to ascertain the performance of these sample pumpsets against guaranteed values

All the tests were carried out in accordance with IS 9137 but uncertainty level in the measurements carried out during the tests was much better than IS stipulations, especially for the flow rate and pressure measurement.

It was recommended that :

- The submersible pump set having highest efficiency and lowest temperature rise should be preferred as this would ultimately result in energy efficient operation and long-term reliability of the pump set

- While selecting the pump sets on technical merits, preference be given to the submersible pump unit having highest guarantee factor, reason for this being the higher the guarantee factor, closer it would operate to the guaranteed duty requirement

- It would be worthwhile to randomly select pump sets from the actual batch of supply and get these tested at CWPRS for ensuring better quality of performance of the actually supplied pumpset

HYDROELECTRIC, THERMAL AND NUCLEAR POWER PROJECTS

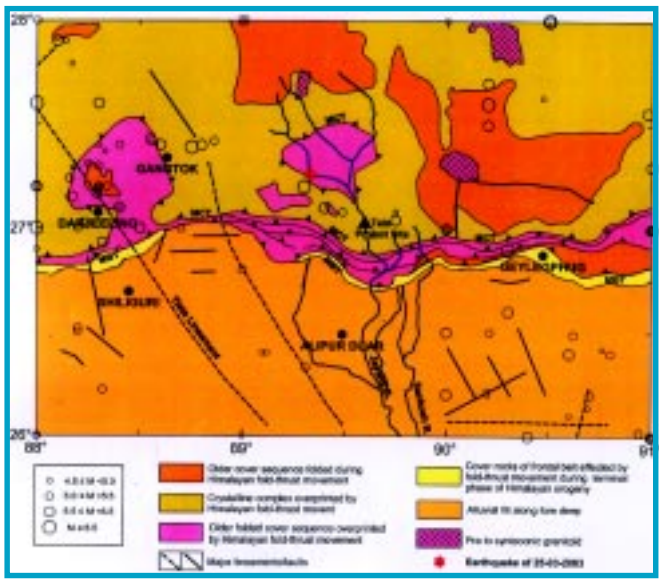
STUDIES REPORTED : HYDROELECTRIC, THERMAL AND NUCLEAR POWER PROJECTS

HYDRAULIC AND SEISMOLOGICAL STUDIES FOR TALA H.E. PROJECT, BHUTAN

The Tala H.E. Project, Bhutan envisages construction of a 91 m high concrete gravity dam across river Wangchu near Honka and an underground power house near Tala having installed capacity of 1020 MW (6 units of 170 MW each). The spillway in the middle portion of the dam comprises five sluices of size 6.5 m wide x 13.15 m high with invert at EL. 1320 m and one span of overflow portion of size 4 m wide x 3 m high with ogee shaped crest at EL. 1360 m. All the sluices and the overflow portion have been equipped with radial gates for surplussing flood water. Ski-jump bucket has been provided for energy dissipation for both overflow portion and sluices. The spillway capacity has been provided to pass standard project flood (SPF) with peak outflow of 8575 m^3/s at full reservoir level (FRL) EL. 1363 m and the maximum probable flood (PMF) with peak outflow of 10,600 m^3/s at reservoir water level EL. 1365 m. Earlier, the studies were conducted at CWPRS using the 1:60 scale comprehensive physical model and considerable modifications were suggested for spillway and stilling basin configurations.

The studies on the original design of sluices with elliptic type of roof indicated that the sluices would be subjected to large negative pressure for discharges higher than 9000 m^3/s passed under ungated operation of spillway and might lead to cavitation damage. Studies were therefore, conducted for minimizing the sluice roof pressures by changing the sluice profiles and for evolving discharging capacity curves for partial gate operation of sluice spillway on a separate 1:40 scale 2-D sectional model. As the Tala H.E. Project is located in the highly seismic Himalayan tectonic province, the seismological studies were also carried out by CWPRS. The studies were conducted with ungated operation of spillway sluice for maximum probable outflow flood of 10600 m^3/s, SPF of 8875 m^3/s and 75% of SPF i.e. 6431 m^3/s. The pressures over the roof profile of sluice for lower discharges with gated and ungated operation were acceptable. Three alternative roof profiles were studied. For alternative-III with circular (45^0) profile, the negative pressures were comparatively less than all other alternatives designs i.e. cubic and circular (37.8^0). The cavitation index corresponding to maximum negative pressure was greater than the critical value of 0.2. The Alternative III profile was recommended. The discharging capacity curves for spillway with all sluices operating under full and partial gate operation were suggested. It was observed that under fully open condition of gates, a discharge of 10200 m^3/s would be passed at reservoir water level EL. 1363 m.

On the basis of historical seismicity, various tectonic features in the proximity of Tala project were indicated to be seismically active. To delineate these features and to assess their seismogenic potential, comprehensive microearthquake studies were taken up by employing one microearthquake (MEQ) recorder and strong motion



▲ *Major Seismotectonic & Geological Features in Tala H.E. Project*

accelerograph (SMA) at Tshimalakha site which is close to dam and other at Piping observatory, at about 30 km d/s of dam. The data were recorded during the period January 2002 to December 2003 and these

microearthquake records were analysed to estimate the epicentral distances from the recording station and the magnitudes of the microearthquakes. It was seen that the level of seismic activity recorded at Piping station during June-December 2003 was quite uniform and stable. Major concentration of seismic events was estimated to be beyond 30 km from this observatory. However, suitable data of microearthquake could not be obtained at Tshimalakha site due to malfunctioning of the instrument during this period. To find the location of the epicenters and to establish their association with the tectonic features in the area, a network of atleast three stations was recommended. Though the level of seismic activity during the current period of study was found to be low, one significant event occurred at about 64 km from the Tshimalakha site, which triggered the SMA at the site. The usefulness of the SMA records to estimate the Richter's local magnitude was also illustrated.

STUDIES FOR FLUSHING OF SEDIMENT FROM RESERVOIR FOR PARBATI-II H.E.PROJECT, HIMACHAL PRADESH

The Parbati river basin is located in the Himalayan range in Kullu district. The total catchment area of the Parbati river upto Pulga dam site is 1155 sq.km. The Parbati river brings down considerable amount of sediment load particularly during flood season because of its steep bed gradient and also due to being fed from the mountainous catchments. The Parbati-II Hydroelectric Project envisages construction of an 85 m high concrete gravity dam to create a gross storage of 6.82 Mcum and live storage of 3.09 Mcum. Due to heavy sediment load the reservoir would be silted up very fast and even encroach live storage in a span of 2 to 5 years. As such it is proposed to flush the sediment from the reservoir by lowering the water levels so as to gain the live storage of 3.09 Mcum. The installed capacity of this project has been proposed as 800 MW comprising 4 units of 200 MW each. Prior to taking up the construction, the studies were conducted at CWPRS for flushing of sediments from the reservoir.

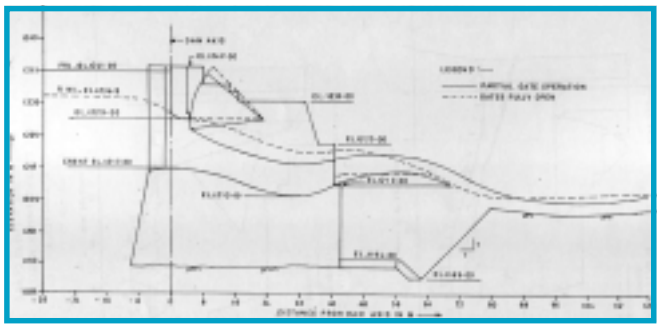
The hydraulic model studies were conducted in 1/70 G.S. scale model covering a reach of the Parbati river of 1.65 km upstream and 0.5 km downstream of the dam axis. The Tosh nallah was also reproduced up to 0.8 km above confluence of the river and nallah. The studies were carried out with flushing discharges ranging from 150 m^3/s to 925 m^3/s for different flushing durations after reproduction of the probable siltation profiles as supplied by the Project Authorities. The studies indicated that the effect of flushing was reaching upto the upstream end of the reservoir. With flushing discharges of 150 m^3/s, it would be possible to flush out 0.68 to 1.3 Mcum for flushing duration equivalent of 24 to 72 hrs respectively. The average annual siltation of 0.6-0.7 Mcum is estimated by the Project Authorities and it was recommended to flush out the reservoir once in a year for one day. The present layout of the spillway would be able to flush out most of the incoming sediments with the restoration of reservoir capacity to a large extent.

STUDIES FOR SPILLWAY OF URI-II H.E. PROJECT, JAMMU & KASHMIR

The proposed Uri-II H.E. Project on river Jhelum is located in Uri Tehsil of Baramulla district of Jammu and Kashmir state. The project is a run-of-the river scheme and envisages construction of a 52 m high concrete gravity dam on the river near Salamabad village and an underground power house at Sadwanian village located on the left bank of river with installed capacity of 240 MW. The water from the reservoir would be conveyed to the power house through a head regulator followed by a 682 m long open channel and 4275 m long head race tunnel. A total discharge of 225 m^3/s with gross head of 130 m would be utilized for generation of power. The water from the powerhouse would be discharged through a 3775 m long tailrace tunnel into Goalta Nalla, which finally meets the river Jhelum at Uroosa. The spillway is designed to pass the maximum design outflow flood of 4850 m^3/s at FRL EL. 1241 m and also to flush the sediment deposited in the reservoir into the river downstream. A breast wall spillway has been proposed with four low level orifices of size 9 m wide x 12 m high with crest level at EL. 1217 m. A ski-jump bucket with an apron was proposed for energy dissipation. The hydraulic model studies were conducted at CWPRS to assess the performance of the spillway for various discharges upto the design discharge using a 3-D comprehensive physical model (scale: G.S. 1/50).

▲ *Flow Conditions Downstream of Spillway for Q = 4850 m^3/s*

The studies indicated that the design discharge of 4850 m^3/s could be passed through three spans at reservoir water level EL. 1239.5 m as against FRL EL. 1241 m. Thus, the discharging capacity of spillway was more and either the spillway could be raised by 1.5 m or gate size could be reduced suitably. The trunnion of the radial gates was well above the water profile. The height of piers was adequate. The flow conditions upstream of spillway and head regulator were satisfactory. The hydrostatic pressures over the spillway surface and bottom profile of breast wall were acceptable. Performance of ski-jump bucket was satisfactory. The flow conditions in the river downstream were observed to be violent. The impact of ski-jump jet would cause progressive erosion of the river bed downstream. Further studies would be conducted for flow conditions and expected scour profiles for various discharges by reproducing erodible river bed in sand.



▲ *Water Suface Profile for Q = 4850 m^3/s along Centre of Span*

STUDIES FOR DAM SPILLWAY FOR SEWA H.E. PROJECT STAGE-II, JAMMU & KASHMIR

Sewa H.E. Project, Stage-II in Jammu & Kashmir envisages construction of a 53 m high concrete gravity dam in Kathua district. The spillway with crest at EL. 1168.0 m is designed to pass the maximum outflow flood of 4020 m^3/s at FRL EL. 1197.5 m and it would also be used for flushing the sediment deposited in the reservoir. Spillway consists of 4 spans, 7 m wide x 10.8 m high separated by 6 m thick piers and equipped with radial gates and 18.7 m high breast walls between the piers. A stilling basin with an apron at EL. 1151 m is provided for energy dissipation. The power intake is located on the right bank of the river at about 20 m upstream of dam axis. 2-D shaped tunnels having invert at EL. 1178.0 m will carry design discharge of 29.1 m^3/s. Water conductor system consists of two power intake tunnels (3.0 m dia, D-shaped), desilting arrangement (Dufour type) and 10.02 km long headrace tunnel (3.3 m dia, horse-shoe shaped) with surge shaft at the end. The surface power house having installed capacity of 120 MW (3 x 40 MW) is located on the right bank of Sewa river.

The hydraulic model studies were conducted for the original design of spillway on 1:50 scale comprehensive model. The general direction of the flow in the reservoir approaching the spillway was oblique with reference to dam axis, generally from left towards the right due to sharp bend at ch. 700 m from dam axis. However, obliquity of approach flow did not show any adverse effects on discharging capacity or overall performance of the spillway. The studies were conducted for the discharging capacity of the spillway for the entire ranges of reservoir water levels keeping all four gates open. The model studies indicated that the maximum design discharge of 4020 m^3/s could be passed through 4 spans with the reservoir water level at EL. 1188.8 m as against FRL/MWL at EL. 1197.5 m and therefore, the discharging capacity of the spillway was found to be adequate. It was observed that there were no negative pressures along the centre line of the span. However, a negative pressure of 0.9 m was observed along the side of pier at distance of 7.8 m downstream of dam axis while passing 25% of discharge ($Q = 1005\ m^3/s$) under partial gate operation. The corresponding flow cavitation index as of 0.3 was greater than critical cavitation index of 0.2. The spillway profile was satisfactory in respect of pressures. It was suggested that the height of the training wall be suitably raised based on water surface profiles observed in the stilling basin taking into account the bulking of flow due to air entrainment in the prototype and requirement of free board. The performance of the stilling basin was observed in the model for the entire range of discharges. It was observed that satisfactory hydraulic jump was forming in the basin upto 50% i.e. 2010 m^3/s of maximum outflow discharge. For higher discharges, the hydraulic jump was getting submerged and consequently returns flows were observed in stilling basin. The return flow at the surface over the drowned jet was emanating in the vicinity of the end sill and travelling upstream towards the rear slope of the spillway. The flow conditions downstream of stilling basin in the river portion were uniform without any appreciable waves. A 15 m wide concrete apron of suitable thickness laid on fresh rock, properly anchored and keyed at the downstream end was recommended just downstream of end sill. It was suggested that all the four spans of the spillway should be operated equally for passing various discharges.

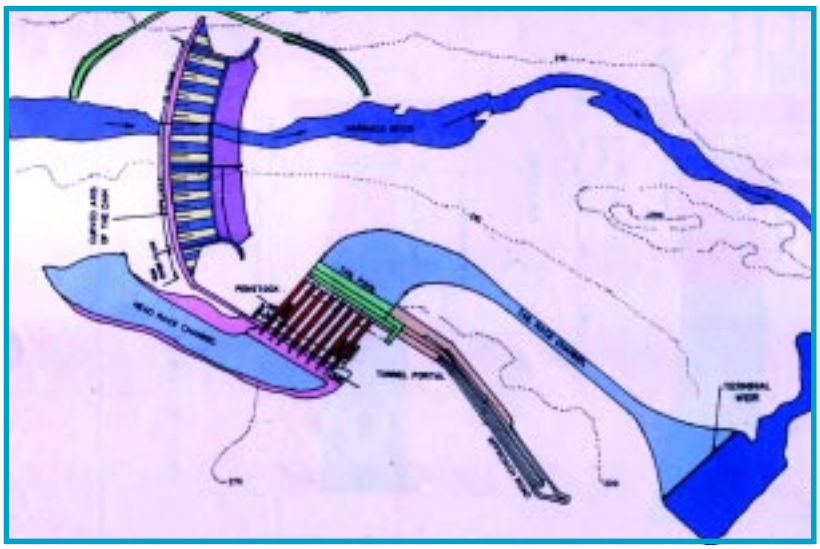
POWER INTAKE OF HEADRACE CHANNEL, INDIRA SAGAR PROJECT, MADHYA PRADESH

Indira Sagar is a multipurpose river valley project with an installed capacity of 1000 MW and annual irrigation capacity of 2.70 lakh hectare located at 13 km downstream of village Punasa in Khandwa district. This project comprises a 653 m long and 92 m high concrete gravity dam across the river Narmada, an open trapezoidal head race channel emanating from Narmada Sagar reservoir, eight intake structures, eight penstocks connected with eight number of Francis turbine units with design discharge of 275 m^3/s and design net head of 60 m. The discharge from eight number of turbine units is led to eight draft tubes, a tailpool, a tailrace channel, a terminal weir and then to the Narmada river. The project authorities proposed to operate unit (1) of the powerhouse with reservoir levels lower than the MDDL 243.29 m. The lowered reservoir levels varied from EL. 234 to 238 m.

The problems of flow separation in front of intake & occasional entrainment arise with the reduction of submergence over the intake at the lower water levels. The second problem arises due to lesser effectiveness of anti-vortex device. The studies were conducted at CWPRS on 1:35 scale geometrically similar composite model for the hydraulic performance of power intake with lower reservoir water levels. The discharge from the unit (1) was also reduced corresponding to the rated discharge and various combinations of submergence were studied.

The model studies were carried out for reservoir levels at EL. 234m to 238m in the incremental step of one meter for discharges of 100 m^3/s, 150 m^3/s, 175 m^3/s and 220 m^3/s .The studies indicated that submergence provided over unit (1) for the lower discharges upto 150 m^3/s was adequate, however for higher discharges upto 220 m^3/s, though the submergence was adequate from the vortex formation upstream of intake, possibility of air entrainment through gate slot was observed.

▲ *View of all Eight Penstocks & Valves Fitted in Penstocks to Regulate Discharge in Model*



◀ *General Layout Plan*

STUDIES FOR SUBANSIRI LOWER H.E. PROJECT, ARUNACHAL PRADESH, ASSAM

Subansiri Lower H.E. Project is located on river Subansiri on the border of the states of Arunachal Pradesh and Assam. The project envisages construction of a 116 m high concrete gravity dam creating a gross head of 91 m for power generation. A surface powerhouse on the right bank with an installed capacity of 2000 MW is proposed. The spillway consists of 9 spans of 11. 5 m (W) x 14.7 m (H) with breast walls. The energy dissipation arrangement is provided in the form of ski-jump bucket with apron and a performed plunge pool for dissipation of energy. The spillway is designed for a maximum outflow flood of 35,000 m^3/s at MWL EL. 208.25 m. The studies were conducted at CWPRS on a 1:90 scale comprehensive model incorporating spillway, power intakes and river reach up to 800 m upstream and 1100 m downstream of dam axis. The studies were also conducted in a 1:100 geometrically similar model for estimating the flushing of the reservoir for various discharges.

The studies indicated that the flow conditions upstream of the spillway were satisfactory for the entire range of discharges and reservoir water levels. The design discharge of 35,000 m^3/s could be passed through all nine spans freely flowing with a reservoir water level of EL. 199.4 m as against MWL EL. 208.25 m. A discharge of 39,150 m^3/s could be passed at MWL EL. 208.25 m, whereas a discharge of 37,700 m^3/s could be passed at FRL EL. 205.0 m through all nine spans freely flowing. Thus, the discharging capacity of the spillway was found to be adequate. The height of the trunnion axis of the radial gates was adequate, as the water surface profile was not touching the trunnion axis for the design maximum discharge of 35,000 m^3/s. However, the height of the divide walls was inadequate from chainage 60 m to the end of the lip as the water surface profile was overtopping the divide walls. The pressures were positive throughout the profile of the spillway for the entire range of discharges except at one or two locations. The maximum negative pressure was of the order of -2.0 m of water head along side of pier. The pressures on the breast wall profile were positive for all discharges with gated operation of the spillway.

Flow conditions in the vicinity of the original layout of power intake were tranquil and no circulation currents were present at MDDL EL. 181.0 m. Flow conditions were also satisfactory for higher reservoir levels. The orientation of intakes was revised in order to reduce silt deposition at front. Flow conditions near the revised layout of the power intake were found to be tranquil without any vortex formation for the entire range of RWL from FRL EL. 205.0 m to MDDL EL. 181.0 m. Thus, the location and spacing of the intakes was found to be acceptable. Location and design of the plunge pool was suggested based on model studies and analytical calculations.

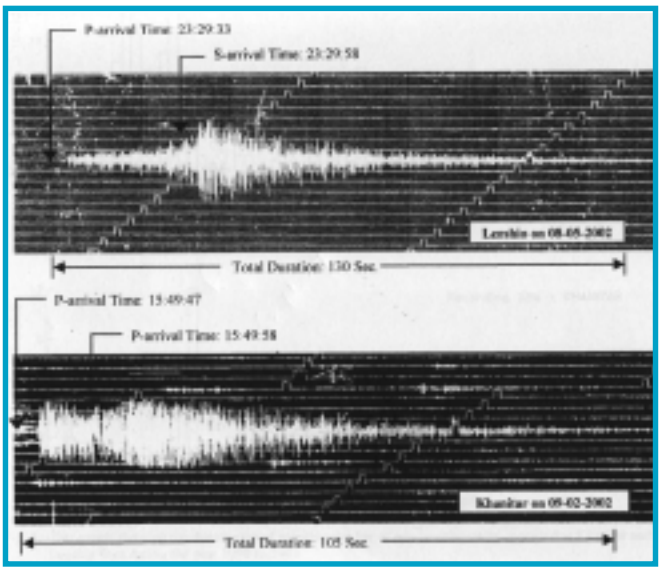
The reservoir silt flushing model studies were carried out with flushing discharges ranging from 6000 m^3/s to 7500 m^3/s. The studies indicated that the effect of flushing was reaching upto the upstream end of the reservoir and the substantial quantities of the sediment would be flushed out and the reservoir capacity could be restored to the maximum extent. Thus, the layout of dam and power intake was suitable for flushing of sediment from the reservoir.

SEISMOLOGICAL STUDIES FOR TEESTA H.E PROJECT, STAGE-VI, SIKKIM

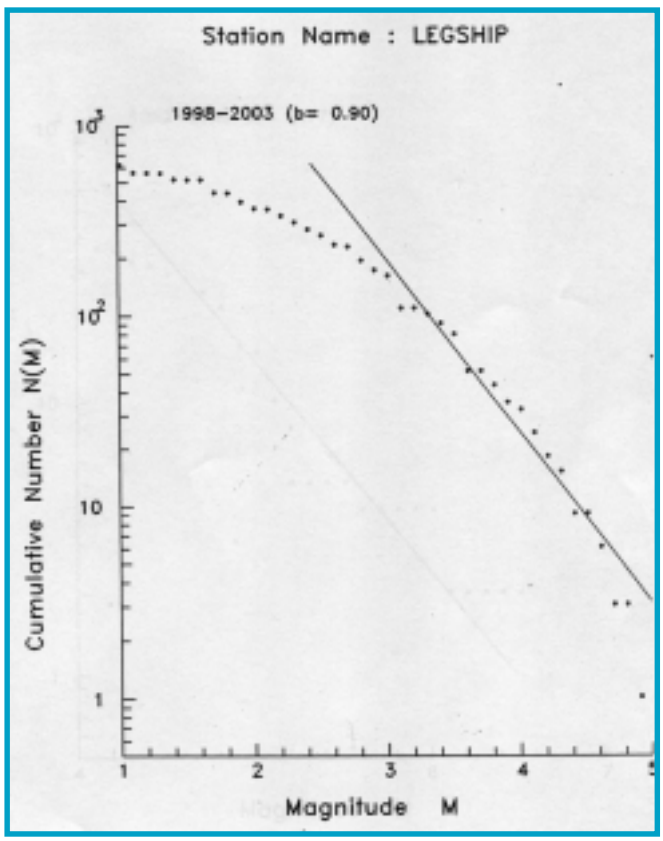
The Teesta H.E. Project, Stage-VI in Sikkim is located on river Teesta in the highly seismic Himalayan tectonic province. Various regional tectonic features passing by the project area had shown seismic activity in the past on their different segments. To assess the seismic status of these features in the vicinity of the Teesta project site and to delineate some unknown seismogenic features in the area, comprehensive microearthquake studies were carried out by CWPRS.

The microearthquake data were recorded during the period September 1998 to December 2003 by establishing three seismological observatories at and around the project site. These data were further analyzed to estimate the epicentral distances from the recording stations and the magnitudes of the microearthquakes. From the present study, it was seen that the activity recorded by the Khanitar observatory close to the dam site was very infrequent and at microearthquake level only. On the other hand, more number of shocks were recorded within 200 km of the other observatory at Legship at a distance of about 28.5 km NW of the dam site.

Due to lack of simultaneous recording at all the three stations, the epicentral locations could not be estimated for any of the local earthquakes during the present period of investigations,. However, from the distribution of epicentral distances from the Khanitar and the Legship observatories, the microearthquake activity was interpreted to be quite consistent with the spatial distribution of the past seismicity in the larger magnitude range. Also, the empirical parameter known as b-value which is related to the state of stress at source based on the local microearthquakes was found to agree well with the regional value based on the historical seismicity. To get a more exact idea about the level of microearthquake activity in the Teesta project area, it was recommended to continue the monitoring for some more time.



▲ *Typical Micro Earthquake Records and Their Analysis*



▲ *Estimation of B-Value by Fitting Magnitude-Frequency Relationship to Microearth Quake Data Recorded at Legship Site*

STUDIES FOR TEESTA LOW DAM PROJECT STAGE-III, WEST BENGAL

Teesta Low Dam Project, Stage–III is located on river Teesta in the state of West Bengal. The project envisages construction of a 32 m high barrage with total length of 140 m comprising seven bays each made up of about 200 m long RCC raft. The spillway consists of seven spans each with an opening size of 14 m (W) x 14 m (H) with breast walls and separated by a double pier each 3.5 m thick. A surface powerhouse on the right bank having an installed capacity of 132 MW is proposed. The energy dissipator is provided in the form of a stilling basin. The maximum design discharge for the spillway is 10,430 m^3/s. The FRL and MDDL are at EL. 208.0 m and EL. 203.0 m respectively. The studies were conducted at CWPRS using a 1:60 scale comprehensive model to assess the flow conditions upstream and down stream of the spillway, discharging capacity of the spillway for full gate opening, performance of the spillway and flow conditions in the vicinity of power intake.

The studies indicated that the flow conditions upstream of the spillway were satisfactory for the entire range of discharges and reservoir water levels, except formation of insignificant and weak vortices for design maximum discharge of 10,430 m^3/s. The design discharge could be passed through all the seven spans with full gate opening, with a reservoir water level of EL. 197.6 m as against FRL EL. 208.0 m. The discharging capacity of the spillway was found to be adequate. As the water profile was touching the trunnion axis of the radial gates for design maximum discharge of 10,430 m^3/s with all the spans flowing freely, it was suggested to raise the elevation of the trunnion axis by about 2 m (at EL. 198.36m) which was found to be suitable. Since the water profile was overtopping the left training wall, right training wall, and the top of the intermediate divide walls, it was suggested to raise the height of these walls suitably to avoid overtopping, bulking of flow due to air entrainment and to get the minimum required free board. The pressures were positive throughout the profile of the spillway for the entire range of discharges for the free flow and partial gate operation of the spillway. The recommended spillway crest profile with downstream profile conforming to equation $x^2 = 72\,y$ and upstream profile conforming to

$$\frac{x^2}{(3.4)^2} + \frac{y^2}{(1.0)^2} = 1$$

was found to be suitable. The pressures on the breast wall profile were positive for all discharges with gated operation of the spillway. There was no orifice flow for the ungated operation of the spillway, as the reservoir water level did not rise above EL. 197.6 m.

Flow conditions in the vicinity of power intake were tranquil and no circulation currents were observed for the entire range of reservoir levels, hence, the location was found to be suitable. The tail water levels observed on the model at Ch. 225 m downstream of barrage axis were found to be higher by about 2-3 m in front of the spillway than the tail water levels supplied by project authorities. The mound in front of the spillway was dressed down by about 4 m to EL. 182 m. The tail water levels after dressing were found to be less by about 1 m or so. However, the water levels in the tail race channel were lowered by 2-3 m than the water levels in front of the spillway for the condition of both spillway and power house operating. The right bank of the tail race channel was also modified to reduce the return velocities.

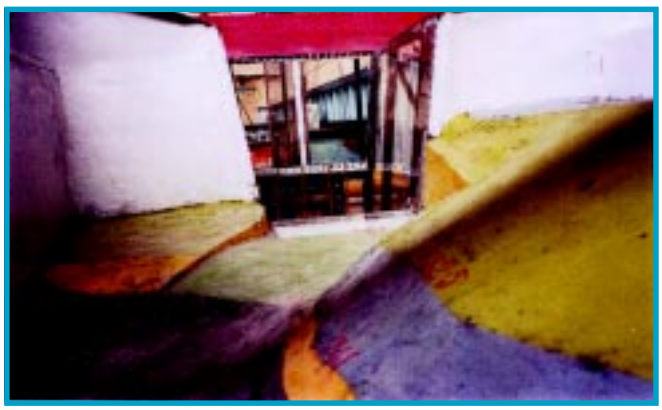
POWER INTAKE OF KUTTIYADI HYDROELECTRIC PROJECT, KERALA

Kerala State Electricity Board, intends to construct extension to Kuttiyadi hydroelectric power project of capacity 2 x 50 MW on Kuttiyadi River, which is 52km away from Kozhikode in Kerala. The powerhouse proposed for this scheme is an extension to the existing powerhouse of I x 50 MW capacity, which is in operation since year 2000. Karnataka Power Corporation Limited (KPCL), are the consultants for the above project who also provided the basic hydraulic designs of the water conductor system. They wanted to ensure, through physical model studies, that the intake would operate without any air entraining vortices and that the flow was stable under the design conditions. This is important as even 1% of air drawn in the intake causes upto 15% drop in discharge. Further, any instability in the flow can cause corresponding flow induced vibrations / instabilities in the turbine. As such, both the phenomena have to be avoided. Hydraulic model studies were undertaken on a 1:12 scale geometrically similar model, to check the hydraulic design of the power intake for the purpose.

▲ *View of Bellmouth & Rectagular Tunnel at Teached to Intake*

The model was fabricated using steel / perspex and brick masonry to reproduce topography of the intake. All sides and bottom of the model were constructed in perspex to ensure full visibility from all sides and from bottom with a special provision to observe any sub-surface vortices. Studies were conducted with trash rack in place before the intake. The experiments were carried out in a closed recirculating system containing two circulating pumps and a rotameter to monitor model discharge. Studies started with highest water level and setting of the discharge to the design value. Visual observations were made to observe any surface vortices. Observations were also made to find out any sub-surface vortices from the sides and also from the bottom. Particular care was taken to illuminate the bottom of the model to look for sub-surface vortices. Thereafter, the water level in the model was progressively reduced upto the minimum draw down level.

Hydraulic model studies based on Froudian similitude established that the proposed structure had met all requirements as specified in the scope of study. No air entraining vortices or sub-surface vortices were noticed while drawing rated discharge of 21.38 m^3/s. Dimple formation and weak vorticity of type B was noticed at lower water levels, particularly for levels close to MDDL of 743.0 m. However, these did not entrain air. Other components of the system viz. bell mouth, rectangular tunnel up to gate, gate, air vent, horse shoe tunnel, etc. demonstrated satisfactory performance while drawing rated flow.

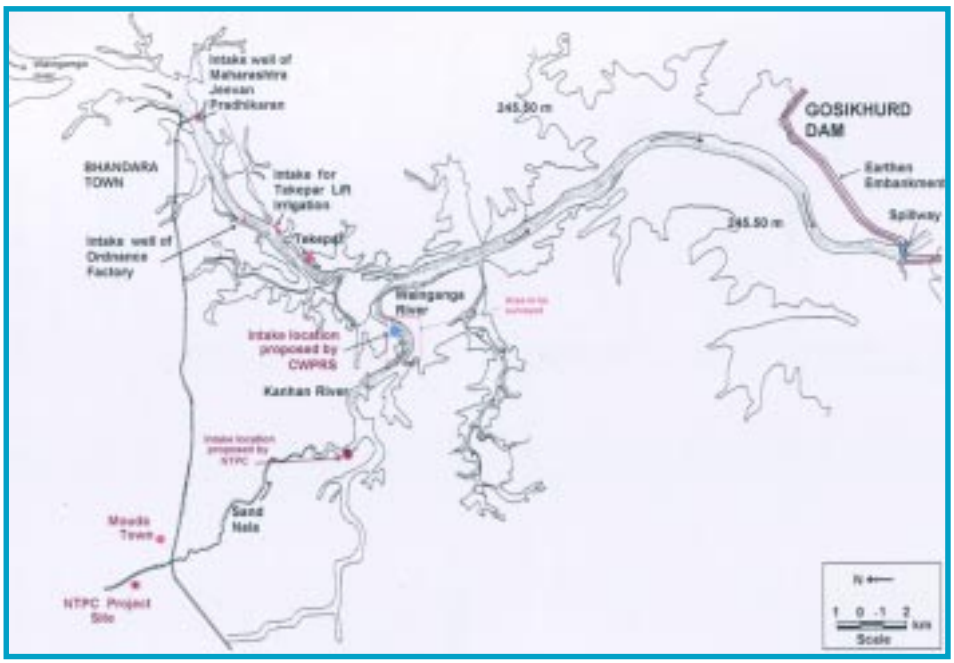


▲ *Overall View of Intake Structure from River Side*

LOCATION AND DESIGN OF INTAKE WELL FOR MOUDA POWER PROJECT NEAR NAGPUR, MAHARASHTRA

National Thermal Power Corporation (NTPC) and Maharashtra State Electricity Board (MSEB) are setting up a joint venture power project of 2 x 500 MW capacity at Mouda in Bhandara district 60 km east of Nagpur. The make up water requirement for ultimate generation has been estimated as 10000 cum/hr. River Wainganga has been identified as the source of water for this project. The studies were conducted at CWPRS for most suitable location of intake in river Wainganga or its tributary namely Kanhan from the point of view of uninterrupted supply of required quantity of water with minimum siltation problem at intake.

Analysis of daily water flow data of Wainganga river indicated that the minimum flows during the summer are in the range of 0.8 m^3/s to 2.0 m^3/s which are much lower than the requirement of 2.85 m^3/s of the Mouda Power Project. On the basis of site inspection, analysis of minimum flow and water level data, and performance of existing intakes of Ordnance Factory and Tekepar Lift Irrigation in river Wainganga, it was inferred that the required quantity of water cannot be ensured without impounding water in Gosikhurd dam. Since the major storage in the dam will be against gates, completion of dam with gate is necessary to meet the water requirements. Considering various aspects such as silting in Gosikhurd reservoir, proximity of deep channel from river bank, availability of water depths at minimum reservoir level etc., it was recommended to locate an intake just upstream of confluence of river Kanhan with Wainganga. A circular intake with two openings of size 4.0 m x 4.0 m with sill level of RL 237.50 m and two openings of same size with sill level at RL 241.50 m were recommended for drawl of relatively silt free water. The upper and lower openings were recommended in a staggered manner to facilitate independent operation of the gates. The top level of the intake was recommended at RL 250.00 m which is about 1.50 m above maximum water level during 100-year return period flood. Detailed topographic survey and geophysical investigations near proposed intake location are necessary before finalizing exact location and foundation level.



▲ *Index Map Showing Location of Intake Proposed by CWPRS*

GEOPHYSICAL & ROCK MECHANICS STUDIES FOR KAKRAPAR ATOMIC POWER PROJECT, UNIT 3&4, GUJARAT

Nuclear Power Corporation of India Ltd is planning to set up two additional units each of 700 MWe near existing Kakrapar Atomic Power Project (KAPP). The site lies on the left bank of river Tapi. The area is underlain by Deccan traps of cretaceous age, which comprise mostly Amygdaloidal basalts overlain by about 7.8 m thick silty soil, brown in colour.

For any nuclear power projects, safety is the first consideration. It is therefore very essential that seismic site characteristics be carried to establish the occurrence of seismic hazard which may alter the overall stability of the structure. As part of the geotechnical investigation, measurement of relevant dynamic parameters both in-situ and in the laboratory are to be made both for determining dynamic rock-structure interaction as well as for seismic response analysis. Designing the earthing system for various electrical installation also demands additional geophysical studies.

Various studies such as cross-hole seismics, seismic tomography, acoustic and electrical borehole logging and dynamic properties of rock samples at the centres of Reactor Building (RB 3&4) and Turbine Building (TB 3&4) of KAPP were carried out by CWPRS. Surface and borehole electrical resistivity measurements were also carried out in the switch yard area of electrical installations.

Cross Hole Seismic Studies

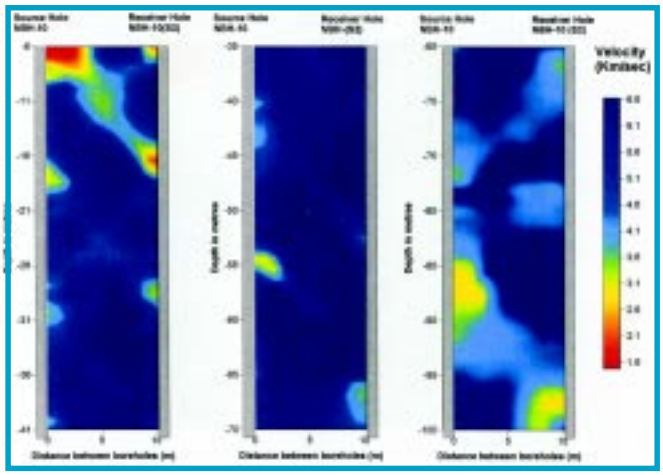
In situ compressional and shear wave velocities with depth are best evaluated by cross-hole seismic technique. The cross-hole seismic studies were carried out at four locations viz. at the centres of Reactor and Turbine Buildings units 3 & 4 using 24-Channel signal enhancement seismograph, borehole hammer with pneumatic/hydraulic clamping device and triaxial borehole geophones. For these studies five NX size boreholes (one source hole and four receiver holes) in two mutually perpendicular directions spaced 5 m apart were rotary drilled upto 30 m depth from the existing ground level.

The compressional wave velocities with depth at Reactor Building (RB) 3 & 4 sites ranged between 530 m/sec and 5620 m/sec. Shear wave velocities for the same strata at these sites varied from 230 m/sec to 3250 m/sec. The lower values of compressional and shear wave velocities correspond to overburden and weathered rock while higher values represent good quality basalt rock.

The corresponding values of dynamic Young's moduli were evaluated to be between 0.03×10^5 kg/cm^2 and 7.52×10^5 kg/cm^2. Dynamic shear moduli values ranged from 0.01×10^5 kg/cm^2 to 3.02×10^5 kg/cm^2 and shear wave velocities with depth at the centres of turbine building units 3&4 were almost same as those observed entries. It was inferred from the studies that the inhomogeneities had no preferential direction of orientation. Therefore, the average of the two sets of velocities at any depth was suggested as the representative value of the strata at that level.

Tomographic Studies

The tomographic studies at RB-3 and RB-4 sites were conducted upto 70 m and 100 m depths respectively using 24-channel signal enhancement seismograph, borehole hammer with hydraulic clamping device and hydrophone string having 12 hydrophones at 1 m interval.



▲ *P-Wave Velocity Distribution Tomogram at RB-Site*

It was inferred from the velocity distributions at RB-3 and RB-4 sites that the rock with depth was generally of good quality except at about 87 m depth at RB-4 site where a zone having some what inferior rock was deciphered.

Acoustic Logging

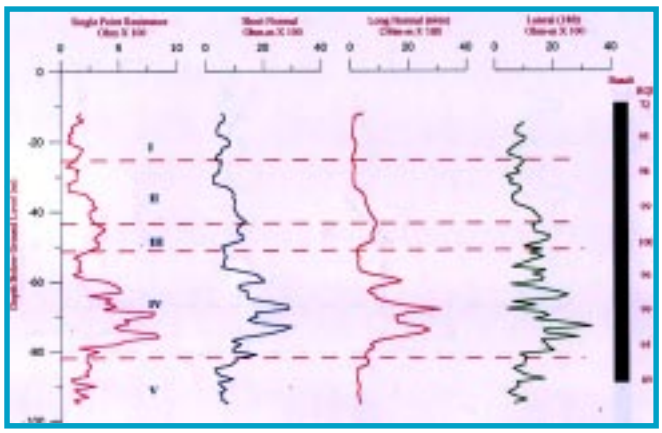
Acoustic logging of the boreholes was carried out using sonic probe and Robertson's well logging unit up to a depth of 88 m below ground level. The data was analyzed using WINLOGGER & VIEWLOG softwares.

The results of the studies showed that the compressional wave velocities of rock at RB 3&4 ranged between 4010 m/sec and 6160 m/sec and shear wave velocities varied from 2270 m/sec to 3230 m/sec. It was inferred from the above velocities that in general rock strata was of good quality and in agreement with the RQDs and no faults were identified.

Electrical Resistivity

For designing the earthing system for various electrical installations, electrical resistivity profiling and sounding techniques were carried out, using electrical resistivity equipment at the extension site of units 3 & 4 to decipher subsurface stratigraphy as well as rock topography and to measure the resistivity of the subsurface material. Electrical soundings were conducted at fifty locations in a grid fashion with maximum current electrode separation of 430 m. Electrical Profiling with electrode separations of 15 m and 30 m was carried out using Wenner configuration.

It was inferred from the sounding data that subsurface stratigraphy comprises three layers. The top surface layer was found to have true resistivity between 19 ohm-m and 500 ohm-m indicating the top layer to be inhomogeneous. The second layer with varying true resistivity from 4 ohm-m to 13 ohm-m indicated fairly uniform resistivity. This uniformity was the result of steady moisture conditions and lithological homogeneity. The bottom most layer having resistivity between 100 ohm-m and 800 ohm-m was interpreted to be basalt rock. The depth to this layer from ground surface varied between 4.5 m and 14.2 m.



▲ *Electical Resistivity Logging at RB-4*

Resistivity contour maps for electrode separations of 15 m and 30 m depicting lateral variations of apparent resistivity were drawn. The apparent resistivity from contour map for 15 m electrode separation varied between 11 ohm-m and 28 ohm-m while the same for 30 m electrode separation ranged from 21 ohm-m to 49 ohm-m with higher values towards Northwest area.

Electrical resistivity logging

Electrical resistivity logging were done at four boreholes namely NBH-27 (RB-3), NBH-10 (RB-4),

NBH-44 (TB-3) and NBH-42 (TB-4) for determining electrical resistivity of the subsurface formation using RG Well Logging Unit & ABEM Logging unit up to a depth ranging from 42 m to 95 m below PVC casing. In general electrical resistivity of rock varying from 70 Ohm-m to 3080 Ohm-m revealed that the rock was sound and massive through out the depth with intermittent slightly weathered zones. The resistivity measured from logging correlated well with those made from surface measurements.

Dynamic Properties of Rock Samples

Dynamic properties of rock core samples, such as dynamic elastic and shear moduli, damping ratio and Poisson's ratio were accessed by using Resonant frequency method based on standing wave phenomenon . The density of the rock sample ranged from 2561.9 kg/m^3 to 2050.3 kg/m^3. The dynamic elastic and shear moduli for 28 rock core samples tested ranged from 10.38 GPa to 95.57 GPa and 9.66 GPa to 40.38 GPa respectively. Damping ratio for the rock core ranged from 0.64% to 2.05%. Dynamic Poison's ratio values ranged from 0.10 to 0.25.

WATER AVAILABILITY FOR PROPOSED CAPTIVE POWER PLANT-II, BHILAI, MADHYA PRADESH

Bhilai Electric Supply Company (Pvt) Limited (BESCL) is a company jointly formed by two Government of India Undertakings viz. National Thermal Power Corporation (NTPC) and Steel Authority of India Limited (SAIL). The company is established to set up and operate the proposed Captive Power Plant - II (CPP-II) with a capacity of 2 x 250 MW. The power generated would be mainly utilized to meet the enhanced requirements of Bhilai Steel Plant (BSP) because of its expansion to 10 MT capacity. The water requirement of CPP-II is estimated as 0.85 m^3/s. At present, water for BSP is drawn from Maroda tank and the inflow to this tank comes from it's own catchment as well as through Tandula canal. The other likely sources of water include Kharun and Seonath rivers flowing close to the proposed CPP – II location. The studies were conducted at CWPRS for assessing water availability and for deciding suitable intake location.

The studies were carried out to assess the availability of water from four different sources viz. Tandula Tank, Maroda tank, Seonath and Kharun rivers and their inflow data were collected and analyzed. The maximum annual shortages from each of the sources were estimated to decide storage capacity of reservoir or volume to be exclusively reserved for CPP. The annual maximum shortages were estimated as below :

Source of Water Supply	Data used in Analysis	No. of Years	Annual Shortage (Mcum)
Tandula Tank	*1994 to 2002*	*9*	*22.42*
Maroda –II tank	*1997 to 2003*	*7*	*10.87*
Kharun River	*1989 to 2002*	*14*	*23.01*
Seonath River	*1978 to 2002*	*25*	*22.14*

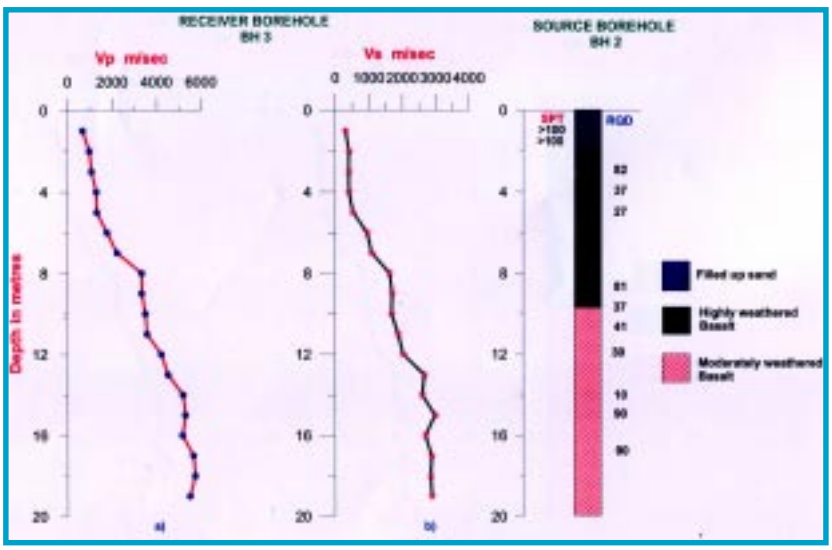
The estimated maximum shortage volume was 86% of the annual demand. It was, therefore, necessary to plan for the annual demand after adding the losses i.e. for total 33.5 Mcum, for functioning of plant under standalone condition. Pros and cons of each alternative were detailed out including the possible intake location and water carrying systems. Techno-economic evaluation of all four alternatives was recommended to decide the best possible proposal of water supply to CPP-II.

CROSS-HOLE SEISMIC STUDIES AT TARAPUR ATOMIC POWER STATION (UNITS 1&2), BOISAR, MAHARASHTRA

At Tarapur Atomic Power Research Station (TAPS), it is proposed to construct a Diesel Generator (DG) Building just behind the existing units 1 & 2 which were commissioned in 1967. The potential effects of vibratory motion caused by design-basis-earthquake were to be taken into account while designing the foundation of the DG building. The transmission of vibratory motion due to an earthquake is governed by Compressional (P-) and Shear (S-) wave velocities of the subsurface strata which are measured by cross hole technique. Mathematical Model studies are being carried out for Seismic Re-evaluation of existing TAPS vis-à-vis earthquake forces, for which shear wave velocity is an important input parameter. Cross-hole seismic studies to evaluate (P-) and (S-) wave velocities upto 19 m depth from existing ground level at 1 m interval at the proposed diesel generator building site were conducted by CWPRS in two mutually perpendicular directions viz., west and south.

The proposed site is situated in the basaltic region of Deccan Traps. The common rock types encountered at the site are amygdaloidal basalt, volcanic breccia / brecciated basalt. A 24-channel signal enhancement seismograph 'Terraloc Mark 6' was deployed for recording of compressional and shear waves. A borehole hammer and two triaxial borehole geophones with pneumatic clamping device manufactured by M/s Geotomographie, Germany were used for generation and detection of seismic waves.

The studies indicated that the compressional wave velocity with depth ranged between 670 m/sec and 5720 m/sec in west direction while the same in South direction varied from 690 m/sec to 5660 m/sec. The shear wave velocity in west direction was evaluated to be between 300 m/sec 2990 m/sec and the same in south direction lied between 320 m/sec and 2930 m/sec. The lower values of compressional and shear wave velocities correspond to overburden while higher values represent basalt rock. No weak zones upto 19 m depth (the maximum depth logged) having appreciable thickness were delineated. The (P-) and (S-) wave velocities in west and south directions at any depth were of the same order. It was inferred from this that the inhomogeneities at this site have no preferential direction of orientation. Therefore, the average of the two velocities at any elevation can be taken as the true velocity of strata at that depth.



▲ *Wave Velocities in West Direction alongwith Source Hole Log*

GEOPHYSICAL & ROCK MECHANICS STUDIES FOR RAJASTHAN ATOMIC POWER PROJECT

Nuclear Power Corporation of India Ltd, is planning to set-up two additional units each of generating capacity 700 MWe near existing Rajasthan Atomic Power Project (RAPP) at Rawatbhatta, Rajasthan. The proposed site is located on the right bank of Chambal river, 6.8 km upstream of Ranapratap Sagar dam. The rock at the proposed site is Chittorgarh fort sandstone of Vindhyan super group. In general the rock mass is of quartzitic type. The soil cap above the sandstone is very thin and the depth of weathering is shallow.

The assessment of shear wave velocity is required both for seismic hazard analysis and for siting of critical structures since this velocity governs the transmission of seismic signal from the earthquake to the site and also controls the site response itself. The magnitude of shear wave velocity in rock is an indication of its quality. Also the values of dynamic Young's and shear moduli help in studying host rock structure interaction in case of occurrence of an earthquake. These moduli are evaluated from the compressional and shear wave velocities and density of subsurface strata. For designing of earthing system for transmission towers and other electrical installations variation of electrical resistivity of the strata laterally as well as with depth is required. The knowledge of these resistivities is also useful for geologic correlation, determining bed boundaries, lithological changes and identifying fractures in rocks.

Various studies such as cross-hole seismics, seismic tomography, acoustic and electrical borehole logging and dynamic properties of rock samples were carried out by CWPRS, at the centers of Reactor Building (RB 7&8) and Turbine Building (TB 7&8) of RAPP. Surface and borehole electrical resistivity measurements were also carried out at the plant & switch yard area.

Cross-hole and Tomographic studies

The cross-hole seismic studies were carried out at four locations viz. at the centres of reactor and turbine building units 7 & 8. For these studies five NX size boreholes (one source hole and four receiver holes) in two mutually perpendicular directions spaced 5 m apart were rotary drilled upto 30 m depth.

The compressional wave velocities at the centres of the proposed reactor & turbine building sites ranged between 1760 m/sec and 5470 m/sec. Shear wave velocities for the same strata at these sites varied from 840 m/sec to 2990 m/sec. The lower values of compressional and shear wave velocities correspond to weathered rock while higher values represent good quality quartzitic sandstone. The corresponding values of dynamic Young's moduli were evaluated to be between 0.49 x 10^5 kg/cm² and 5.95 x 10^5 kg/cm². Dynamic shear moduli values ranged from 0.18 x 10^5 kg/cm² to 2.32 x 10^5 kg/cm². The compressional and shear wave velocities at various depths in two perpendicular directions, for each location, were of the same order. It was inferred from this that the inhomogeneities had no preferential direction of orientation. Therefore, the average of the two sets of velocities at any depth was suggested to be adopted as the representative value of the strata at that level.

In addition to evaluating average compressional and shear wave velocities upto 30 m depth, the tomographic studies deploying compressional waves at RB-7 and RB-8 sites were conducted upto 70 m depth using 24-channel signal enhancement seismograph, borehole hammer with hydraulic clamping device and hydrophone string having 12 hydrophones at 1 m interval to decipher weak zones in the rock. The P-wave arrivals at RB-7 and RB-8 sites

were analysed using straight ray geotomography. The velocity distributions were computed using the Simultaneous Iterative Reconstruction Technique. The velocity field between source and receiver was discretized on a rectangular grid point with spacing between points exactly 1 m vertically and horizontally.

Tomographic studies revealed that P wave velocity in the rock varied between 4.5 km/sec and 5.5 km/sec which for quartizitic sandstone indicated good quality rock. A low velocity zone between 48 m and 70 m depth at RB-7 site was deciphered. This may represent somewhat inferior quality rock. This was corroborated by poor core recoveries obtained in receiver hole at RB-7 site between those depths. From the values of compressional and shear wave velocities, it was inferred that the sandstone rock at site resembled more of quartzite than sandstone.

Acoustic Logging

Acoustic logging was carried out using Robertason's Well Logging Unit for a depth from 15 m to 82 m in boreholes NBH-7 (RB-7) and NBH-22 (RB-8) for total running depth of 135 m to enable determination of compressional and shear wave velocities of formations adjacent to the borehole.

The results of the studies showed that at RB-7, the compressional wave velocities of the formation ranged between 4390 m/sec and 5080 m/sec and shear wave velocities ranged between 2160 m/sec and 2710 m/sec. Similarly, at RB-8, the compressional wave velocities varied from 4620 m/sec to 5120 m/sec and shear wave velocities varied from 2410 m/sec to 2640 m/sec. The study revealed that quartzitic sandstone encountered was sound.

Electrical Sounding and Profiling

Electrical resistivity survey deploying both sounding and profiling techniques was conducted at the extension site of RAPP units 7 & 8 to decipher subsurface stratigraphy as well as rock topography and to measure the resistivity of the subsurface material. Electrical soundings were conducted at 38 locations in a grid fashion with maximum current electrode separation of 50 m. Electrical Profiling with electrode separation of 10 m was carried out using Wenner configuration. Electrical sounding data were finally interpreted using 'INVER' software package.

It was inferred from the sounding data that subsurface stratigraphy comprised three layers. Cross-hole seismic results were used to correlate with geoelectric layers. It was found that at the locations where both cross-hole and electrical soundings were carried out the depth to last layer inferred in resistivity survey matched with the rock depth having compressional wave velocity of 4000 m/sec and above. It was inferred that the depth to good quality rock at plant site varied between 2.0 m and 10.2 m.

It was seen from the contour map of 10 m interval that the apparent resistivity of central portion of the area at the plant site was more as compared to that on edges. Also the apparent resistivity variation was large (800 to 3300 ohm-m) at the plant site as compared to that (800 ohm-m to 1100 ohm-m) in the switch yard area.

Electrical Resistivity Logging

Electrical resistivity logging were done at four boreholes for determining electrical resistivity of the subsurface formation using Robertson's Well logging Unit & ABEM Logging unit for a depth ranging from 15 m to 85 m in boreholes NBH-7 (RB-7) and NBH-22 (RB-8) and 15m to 50m in boreholes NBH-10 (TB-7) and NBH-26 (TB-8) for a total running depth of 210 m.

The results of the studies showed that in general electrical resistivity of rock varied from 200 Ohm-m to 1900 Ohm-m. Presence of low resistivity zones

ranging between 200 Ohm-m and 1000 Ohm-m were observed in ferrugenous siltstone formations. High resistivity values above 1000 Ohm-m were observed in quartzitic sandstone.

Dynamic Properties of Rock Samples

Dynamic properties of rock core samples, such as dynamic elastic and shear moduli, damping ratio were determined by using Resonant frequency method based on standing wave phenomenon. In this method the rock specimens were subjected to longitudinal and torsional vibrations at different frequencies to determine the resonance frequency from which velocity of the elastic waves as well as the dynamic moduli of the cores were computed. The density of the rock sample ranged from 2464.3 kg/m^3 to 2644.4 kg/m^3. The dynamic elastic and shear moduli for 38 rock core samples tested ranged from 21.3 GPa to 50.9 GPa and 9.2 GPa to 26.69 GPa respectively. Damping ratio for the rock core ranged from 0.4% to 3.0 %.

INSTALLATION OF WEATHER STATION AND HYDROMET NETWORK FOR KOL DAM HYDROELECTRIC PROJECT OF NTPC, HIMACHAL PRADESH

National Thermal Power Corporation (NTPC) Limited is commissioning its first hydropower project on river Satluj at Kol in Himachal Pradesh. For this purpose a rock and gravel filled dam of height 163 m is being constructed to create 576 Mcum of gross storage for 800 MW hydroelectric power generation.

Satluj river rises in Mansarovar near Rakastal in Tibet and flows through Himachal Pradesh and Punjab in India. The catchment of the river is mountainous and hilly. Most of the area is snowfed except the area in the lower plains in India, which is rainfed. The river is frequently threatened by devastating floods. The studies were conducted at CWPRS to identify locations for installation of weather stations in Satluj river catchment between Rampur and Kol dam for subsequent development of flood forecasting model. The weather stations would enable collection and transmission of rainfall data and other meteorologial parameters such as evaporation, temperature, humidity, atmospheric pressure, wind etc.

A reconnaissance survey was carried out from Kol dam site, along the river in accessible areas, upto Rampur to identify the suitable locations for hydromet data collection through weather and stream gauging stations. Literature review on Manuals and Standards adopted by India Meteorological Department (IMD) and World Meteorological Organization (WMO) was carried out. Keeping in view the requirement of the Kol dam project, locations of observation stations, as well as, specifications of equipments for data collection and transmitting system were suggested.

ASSESSMENT OF INITIAL FEASIBILITY OF SCHEMES FOR SEAWATER FGD SYSTEM FOR DAHANU THERMAL POWER STATION, MAHARASTRA

Dahanu Thermal Power Station (DTPS) was established at Dahanu located at about 110 km north of Mumbai by M/s Bombay Suburban Electric Supply Company Ltd. (BSES), Mumbai in 1995. The cooling water required for the power project is drawn from Savta creek through a shore based pump house. The warm water from the condenser is discharged into Danda creek through a pre-cooling channel. Both Savta and Danda creeks discharge water to Dahanu creek, which is ultimately connected to the Sea. Under the action of tide, seawater enters into Dahanu creek and flows in the Savta and Danda creek. Initial studies for deciding the location and the design of the intake and outfall structures of the power project were conducted at CWPRS with the help of model studies. M/s BSES now M/s Reliance Energy Ltd. (REL), was directed to install a Flue Gas Desulpharisation (FGD) Plant for the DTPS. The studies for the hydraulic feasibility for the retrofit of FGD project for the DTPS were carried out at CWPRS. The work was undertaken in association with M/s Water and Power Consultancy Services (WAPCOS). As a part of the total studies, the baseline survey of site specific data relating to intake-outfall structure was taken up first. Based on the same, alternative of re-use of the cooling water discharge flowing in the pre-cooling channel for the FGD by locating a pump house in the pre-cooling channel, downstream of the seal well was considered to be most suitable. The project authorities identified three alternative schemes as supplied by; i) M/s Alstom Project, ii) M/s Ducon Technologies and, iii) M/s Monsanto Enviro-chem Systems. The studies for assessment of the initial feasibility of these schemes included:

- Assessment of the effect of the constriction caused due to installation of such structures in the pre-cooling channel
- Assessment of the workability of the schemes, from hydraulics point of view
- Recommending further studies required to be carried out to ensure workability of the seawater FGD for each scheme
- Examining whether temperature mitigation of the effluent from the FGD plant would be achieved in the pre-cooling channel in case of each scheme

Prima facie, all the three schemes were quite similar in nature. In every scheme, construction of bund was proposed across the pre-cooling channel to divert the water to the pump house and Sea Water treatment plant (SWTP) system. The effluent from the FGD plant would return back to pre-cooling channel through an outlet system leading to mixing chamber. The balance cooling water would be mixed with the effluent water to enhance the pH value to the level of oxidation before flowing to the oxidation chamber where the air would be blown to achieve conversion of sulphites into sulphates and increase in pH value.

On scrutiny, all the three schemes submitted by M/s REL were initially found to be feasible for implementation with due consideration to the deficiencies indicated which could be taken care by the designer at the time of detailing of the scheme.

ELECTRICAL RESISTIVITY SURVEY FOR TAPOWAN VISHNUGAD HYDROELECTRIC PROJECT, UTTARANCHAL

M/s National Thermal Power Corporation proposes to construct a 360 MW hydroelectric project across river Dhauliganga near village Tapovan in Chamoli district of Uttaranchal. The project envisages construction of a barrage comprising 4 bays of 12m each separated by 2.5m thick piers, a sedimentation tank, a head race tunnel 11.646 km long and 4.8m diameter and a underground power house. For designing the foundations of the barrage and other related civil structures economically, subsurface information about stratiagraphy including rock topography are important parameters and for the earthing system of various electrical installations, resistivity of subsurface material is essential. The studies as referred by M/s WAPCOS, were conducted by CWPRS to determine the resistivities of the subsurface strata.

Electrical resistivity survey using both sounding and profiling techniques was carried out at the proposed barrage, head race tunnel and the switch yard areas. The project area forming a part of Dhauliganga and Alaknanda valley has exposed rock which is classified as Central Himalayan Crystalline. The rocks are mainly composed of medium to high grade metamorphics. The rock types exposed at the barrage site on the right bank are augen gneisses. On the left bank, the lower level is occupied by river borne material comprising rock boulders and excavated debris.

Electrical profiling was carried out by deploying a digital resistivity equipment 'SAS-300' while for electrical sounding survey, microprocessor controlled 'Aquameter' was deployed. Electrical soundings were conducted at twentyfour locations. At each sounding centre six measurements per decade using Schlumberger configuration were made. The current electrode separation, depending on the spread lengths available varied between 136m and 430m. Electrical profiling with 10m electrode separation was carried out in a grid fashion using Wenner configuration at the switch yard site. It was inferred from the results of the sounding data that subsurface stratigraphy including rock comprised two to five layers of different compactness. The top surface layer was found to be inhomogeneous having true resistivity varying between 300 ohm-m and 10810 ohm-m. The overburden layer above rock has true resistivity ranging from 65 ohm-m to 540 ohm-m with fairly uniform resistivity as a result of steady moisture conditions and lithological homogeneity. The bottom most layer was interpreted to be rock having resistivity between 970 ohm-m and 19125 ohm-m. The depth to this layer from ground surface varied between l1.2m and 28.4m. On comparison with the results of seismic refraction survey done earlier, it was observed that the depths to rock evaluated by electrical resistivity method were generally shallower by about 2m. The depths to rock inferred in resistivity survey matched remarkably well with those inferred in few boreholes drilled at the site to study subsurface stratiagraphy.

The electrical profiling at the switch yard was done and resistivity contour map depicting lateral variations of apparent resistivity was drawn. The apparent resistivity of the subsurface strata varied between 250 ohm-m and 700 ohm-m, being less towards northeast as compared to that in the southwest direction.

HYDROLOGICAL AND GEOPHYSICAL STUDIES FOR LATA-TAPOVAN HYDROELECTRIC POWER PROJECT OF NTPC, UTTARANCHAL

National Thermal Power Corporation (NTPC), India has proposed to commission a new hydroelectric power project with an installed capacity of 108 (3x36) MW, near Lata on river Dhauliganga, tributary of river Alaknanda, in Uttaranchal State. The project involves construction of 128 m long barrage near Lata and an under ground power house near village Tapovan. The river basin is mountainous, partly covered with snow and lies in the Himalayan region. Catchment area of river Dhauliganga up to project site is estimated to be 2275 sqkm. The length of the river upto project site is 77 km with average slope of 34.41 m/km. Studies related to assessment of water availability, estimation of Standard Project Flood (SPF) and Probable Maximum Flood (PMF), seismic refraction and electrical resistivity survey at project site were carried out by CWPRS.

The studies for assessment of water availability and estimation of floods were aimed at estimation of ten day flow series, water availability at 90% and 50% dependability and floods of different return periods. The data requirement for such studies are long term observed discharges for a period of about 30 years. The data utilized included flow data observed by Uttar Pradesh Irrigation Department at the sites near the project, 10 day average flow data at Joshimath down stream to the project site, annual maximum peak flood at Joshimath and long term flow data at Raiwala site downstream of Joshimath. The series yielded ten day flow volume of 13.6 and 39.19 M cum. at 90% and 50% dependability respectively. The floods with return period of 100yr and 500 yr were estimated as 2259 m^3/s and 2718 m^3/s respectively.

Hydrometeorological data available with Central Water Commission (CWC), State Government authorities and India Meteorological Department (IMD) were used to develop Synthetic Unit Hydrograph (SUH) up to the project site. Standard Project Storm depths and Probable Maximum Precipitation and their distribution over storm duration, for 1-day and 2-day storms, developed by IITM were utilized. Using synthetic rainfall and SUH developed, SPF and PMF were estimated. The SPF from 1-day and 2-day storms were estimated as 3841.7 m^3/s and 4381.4 m^3/s respectively, while PMF from 1-day and 2-day storms were 6152.7 m^3/s and 6952.0 m^3/s respectively.

Seismic refraction survey was carried out to delineate the bed rock profile and to detect weak zone. Seismic velocity ranged from 300 m/s to 4500 m/s in different layers with different thicknesses. The layers were of sand and boulders, highly weathered and mainly consisting of sand gneiss boulders, gneiss bed rock The result showed that the rock at the left bank of river was at shallow depth of about 12 m which was correlating well with the depth of good rock (RQD 63 percent) in borehole.

Electrical resistivity survey was carried to assess the stratiagraphy of the subsurface strata at barrage site and for designing the earthing system for electrical installation. Vertical Electrical Soundings (VES) were carried out at 13 locations using Schlumberger configuration. Result indicated the presence of four geo-electrical layers consisting of sand, boulders, dry sand and the bed rock. At power house site it was found that the layer was conductive (resistivity range of 68 to 168 ohm-m) and hence was recommended for earthing.

DEVELOPMENT OF FLOOD WARNING SYSTEM AND RESERVOIR SEDIMENTATION STUDIES FOR LOHARINAGPALA H.E. PROJECT, UTTRANCHAL

M/s National Thermal Power Corporation proposes to develop a hydro power project with capacity of 520 MW (4x130 MW), near Loharinagpala, located at about 220 km from Rishikesh, in Uttranchal. The project envisages construction of a barrage across river Bhagirathi, a tributary of river Ganga, and an underground power house near Pala village. The catchment area of the river Bhagirathi upto barrage site is 3316 sq.km. out of which 1849 sq.km. is snow bound and is located above elevation of 4877 m and the remaining 1467 sq.km. situated below EL. 4877 m, experiences snow in winter and remains covered with green vegetation in summer. The project site is in Himalayan region and suffers from intense and short duration floods. The river carries large sediment in suspension as well as on bed with grain size varying between 0.004 mm upto a maximum of 600 mm. The studies for development of suitable flood warning system (FWS) and reservoir sedimentation were carried out at CWPRS.

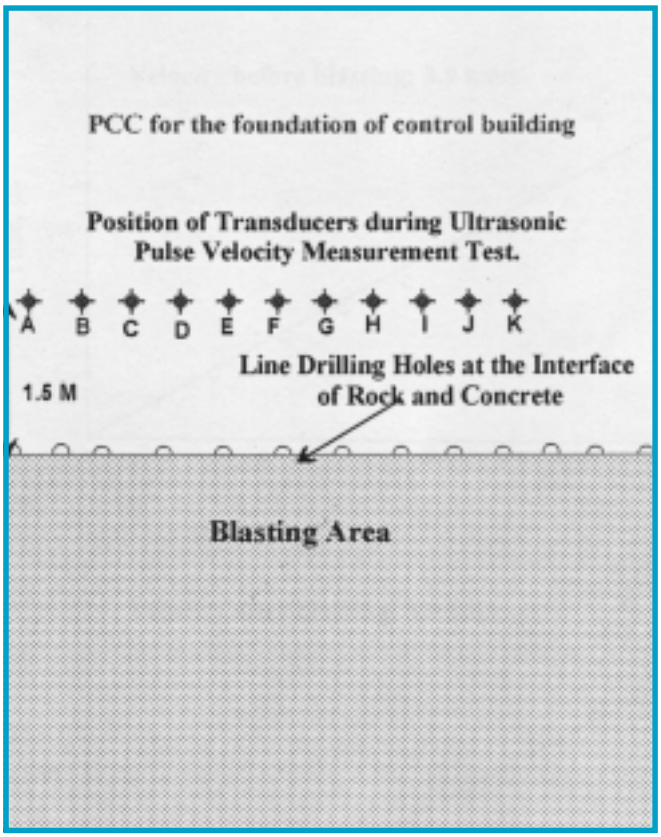
The site inspection was undertaken in October 2004. The different components of the FWS were identified and were reviewed considering the norms of Bureau of Indian Standards (BIS) and World Meteorological Organization (WMO) for setting up minimum and project oriented network of gauging stations. The data collection status in project area was reviewed. Considering the difficult terrain prevailing in the project area, it was suggested to install the gauges at barrage site, upstream of barrage site near Gangotri, beyond back water zone, Harsil, Dharali and HRT intake for measurement of precipitation, evaporation, discharge and sediment. Initially, recording type of instruments were suggested and in the second stage, transmitting type of instruments were suggested. A review of rainfall-runoff and channel routing models was taken and a regression type model was suggested for Loharinag Pala project to predict water levels at barrage site using the data on water level at upstream gauging sites. Annual updating of the model was suggested to get stable relationship.

For the reservoir sedimentation studies, the estimation of maximum bed profile that would result during the passage of discharges was done. Daily ten discharges and sediment observed at Maneri site located at about 28 km downstream of barrage axis were used. Simulation runs using model HEC-6 were taken to estimate the bed level after sedimentation. The discharge series corresponding to maximum flow volume in a year was selected. The simulation was carried out under minimum and maximum pond conditions. The loss of days for power generation and the corresponding loss in revenue were estimated which would be helpful in techno-economic studies. An enveloping bed profile was derived and recommended for use by the project authorities.

▲ *Braiding Channel Patterns of Bhagirathi River Upstream of Barrage Axis*

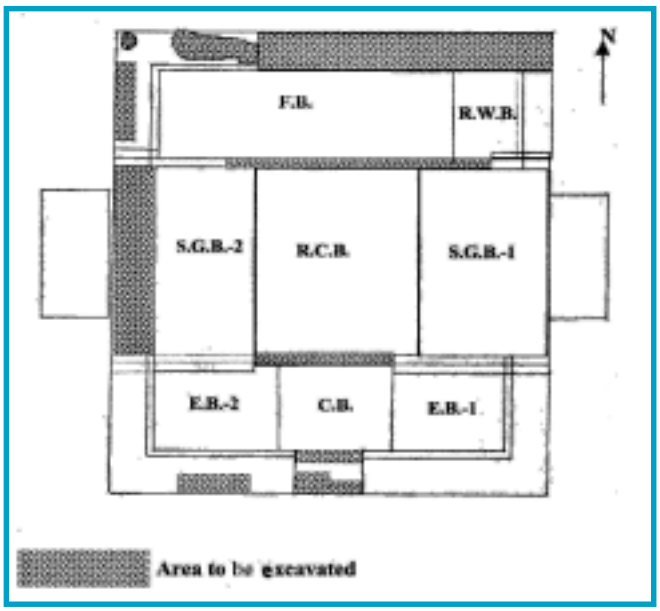
CONTROLLED BLAST STUDIES FOR EXCAVATION OF ROCK AND DETERMINATION OF DYNAMIC PROPERTIES OF ROCK CORES FOR PFBR SITE, KALPAKKAM, TAMIL NADU

The construction of 500 MW Prototype Fast Breeder Reactor (PFBR) project at Kalpakkam, Tamil Nadu, involves excavation of large quantities of rock by drilling and blasting method in the vicinity of several important structures, such as Madras Atomic Power Station (MAPS), Nuclear Desalination Demonstration Plant (NDDP), Administrative Building, Switch Yard and Site Assembly Shop (SAS) buildings. Also, the excavation and concreting was to be carried out simultaneously, which required to safeguard the green concrete of varying ages in close proximity of the blasting area.

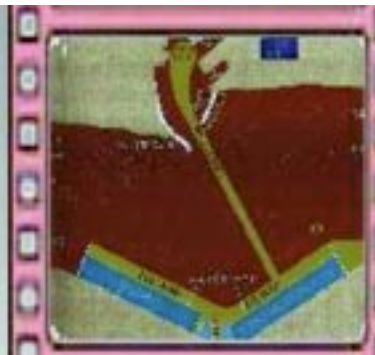


The drilling and blasting method used to excavate hard rock is associated with several unwanted effects like ground vibration, airblast, flyrock and overbreakage, which need to be restricted within acceptable limits. The blasting operation at PFBR site was performed in a controlled way by adopting the following general steps:

- Assessing the maximum permissible vibration level in terms of peak particle velocity (PPV) to avoid damage to various structures located around the blast site and the green concrete of different ages
- Developing a site-specific attenuation relation describing the transmission characteristics of blast vibrations with distance
- Evaluating the safe charge weights that could be used at different distances from the various structures
- Designing the safe blasting pattern and suggesting the procedure for controlled blasting
- Monitoring the blast vibrations during actual rock excavation



COASTAL AND OFFSHORE ENGINEERING



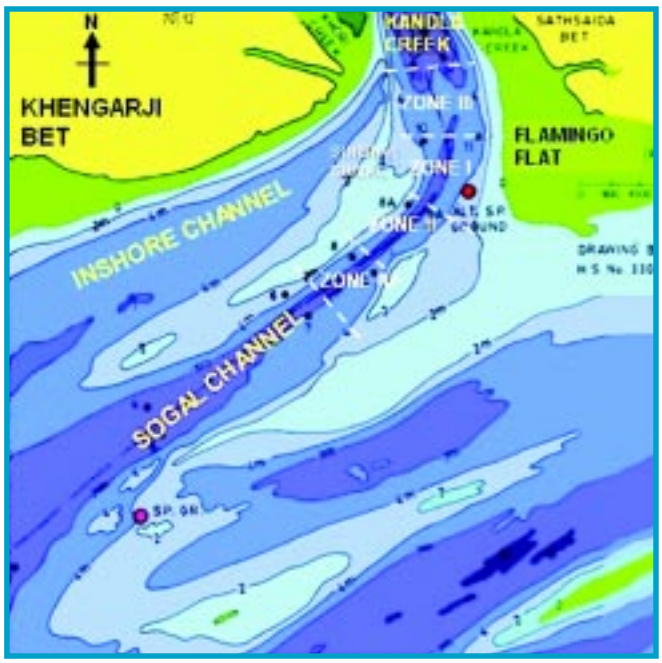
STUDIES REPORTED : COASTAL AND OFFSHORE ENGINEERING PROJECTS

DREDGING AND SILTATION IN SOGAL CHANNEL AT KANDLA PORT, GUJARAT

The Kandla port is an all weather major port located at 120 km from the entrance of Gulf of Kutch. The port is developed along the west bank of Kandla creek which is naturally protected against waves and natural depths ranging between 10m to 18m are available. The shoals which exist in the approaches to the Kandla creek, however, undergo frequent changes resulting in non-availability of adequate depths in part of the navigation channel. The Kandla port has an approach channel of 17 km length from the outfall of Kandla creek to the 10m contour in the Gulf of Kutch. The part of approach channel known as "Sogal channel" has been demarcated into four zones I, II, III and IV respectively of lengths 1600m, 1100m, 1400m and 1300 m for the purpose of maintenance dredging. The strong currents ranging between 1.0 m/s to 2.0 m/s cause high sediment concentration and transport at Kandla. The flow distribution is non-uniform in the approaches to the Kandla creek. The siltation in the Sogal channel is mainly from western side of the channel due to transport of the sediments from and around the Singhvi shoal and south of Khengarji Bet. This is responsible for encroachment of the shallow contours along the northwest bank of the Sogal channel. The downstream reach of the navigational channel has natural depths of more than 6.0 m whereas the upstream reaches located in a curved portion are subjected to high siltation rates.

At present, the Sogal channel is being maintained by continuous dredging on daily basis by using a Trailing Suction Hopper Dredger of 4500 cum capacity (DCI Dredge IX or XI). On the basis of analysis of available dredging data and the prevailing flow conditions, the zone wise requirement of maintenance dredging and the effective strategy for the same to achieve progressive improvement of depths, have been identified by CWPRS along the Sogal channel.

The stability of Sogal channel was studied by analyzing the hydrographic survey charts between July/August 2002 and October 2003. The most critical reach for siltation has been identified as the curved reach of 2300m length between zones II and III. The analysis revealed that the siltation is nearly three to four times in zones II & III compared to that in zones I & II. As recommended by CWPRS, the dredging was mainly concentrated in zone III along the western bank of the channel. The analysis of the dredging data indicated that the maintenance dredging during August 2002 to October 2003 varied from 0.35 to 0.40 Million cum per month.



The Sogal channel has been, by and large, a stable channel due to judicious planning of the dredging strategies as recommended by CWPRS from time to time. This has yielded very good results not only for maintaining the ruling depths but also in the progressive improvement of depths from -3.7 m during it's commissioning in 1984 to -6.5m by 2005. This progressive increase has been obtained despite the dredging quantity being constant over the years.

FIELD DATA COLLECTION AND ANALYSIS FOR PROPOSED MARINE OIL TERMINAL IN PATHFINDER CREEK AT VADINAR, GUJARAT

M/s Essar oil Ltd is establishing a 10.5 Million tonnes refinery at Vadinar near Jamnagar. For handling crude and crude products, it is proposed to have a marine oil terminal in the vicinity of existing Kandla Port jetty in Pathfinder creek at Vadinar. The terminal would consist of two "T" shaped product jetties on piles 1100m away from Kandla Port jetty. The product jetties were proposed to be connected to Kandla Port jetty through a solid bund. On the basis of model studies conducted at CWPRS in 1997, a total length of 1500m for this solid bund was recommended as per the suitability of flow conditions. The construction of solid bund of approximately 1100 m length from Kandla Port jetty to this product jetty was completed and the product jetty was partially constructed. However, construction of rest 400 m length bund beyond first product jetty was not permitted to avoid possible damage to Marine ecology as this area falls under Marine National Park and Sanctuary.

The field studies were conducted for assessing the suitability of product jetty for berthing operations without further construction of 400 m long bund at the proposed site. Measurement of currents to determine flow conditions at the product jetty were done using equipments

- In-situ self recording current meter
- Electromagnetic current meter
- Echosounder with position fixing equipment and
- Acoustic release

These measurements were carried out for the worst conditions viz. during Spring tides for six days at three different locations viz. in front of breasting dolphin, at mooring dolphin and in line with approach bund already constructed. The current observations indicated presence of small cross flow at mooring dolphin and in line of existing bund. The currents at breasting Dolphin where the ship would normally be berthed, did not indicate any cross flow. It was concluded on the basis of field investigations that the cross flow existed but since it was behind the jetty and the magnitude being small, it would not have any adverse effect at breasting Dolphin. It was recommended that the product jetty could be constructed without any further extension of bund.

STUDIES FOR PROPOSED JETTIES AT OKHA AND BEYT DWARKA, GUJARAT

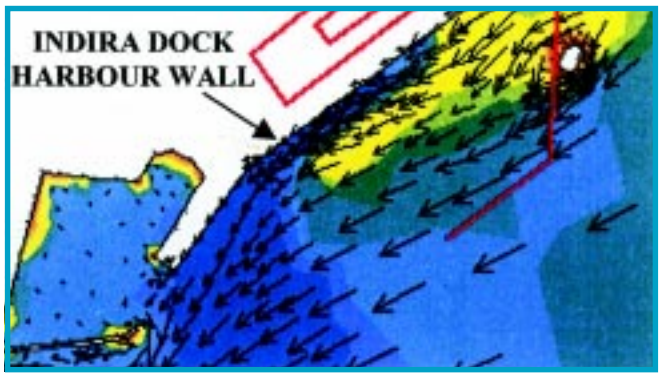
In the Gulf of Kuchchh, an important pilgrimage center at Beyt Dwarka is located at about 2 km away from the main land of Port Okha. To facilitate the crossing of passengers across the gulf, jetties were provided at both the banks about thirty years back which are in damaged condition at present. Hence, it was considered necessary to provide alternative facilities so that the difficulties faced during landing would be minimized. Studies were conducted at CWPRS for finding the suitable locations and alignments of the landing jetties on either side.

Simultaneous prototype data in respect of float tracks and velocities were collected. From the analysis of these data, it was observed that the flood tidal range at Okha was 1.8 m and ebb range was 2.2 m. The hydrographic surveys showed marginal morphological changes around the existing jetty location. On Okha side, the maximum flood current was 1.56 m/sec and ebb current strength was 1.07 m/s during spring tide. On Beyt Dwarka side, these current strengths were 0.96 m/s and 1.19 m/s. The currents were marginally stronger on Beyt Dwarka side. On the basis of desk studies carried out, the alignments along 15° - 195°N for the jetty on Port Okha side and along 0° - 180° N on Beyt Dwarka side were recommended.

FIELD INVESTIGATIONS AND STUDIES FOR DEEPENING AND WIDENING OF INDIRA DOCK HARBOUR AT MUMBAI PORT

Mumbai port located on west coast of India, is a natural harbour protected by Salsette or Mumbai island on the west and mainland on the east. There are three wet docks viz. Indira, Princess and Victoria located in this harbour. The eastern wall of Indira dock is used as an open wharf known as Harbour wall berths with an approximate length of 700 m deepened to -8.5 m depth with channel at -7.3 m. These depths are maintained by dredging at regular intervals. The present rate of siltation in front of this harbour wall is about 3.0 m per annum.

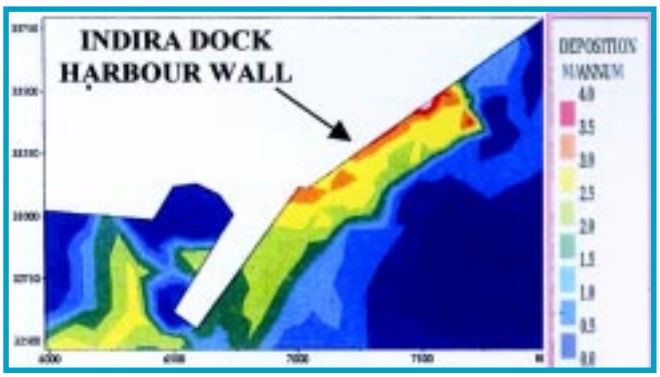
In order to handle higher draft vessels, the Mumbai Port Trust (MbPT) authorities have proposed deepening and widening of navigational area near the harbour wall berths. Under this proposal, the existing 45m wide and - 8.5 m deep pocket near these berths was proposed to be widened to 60 m with a depth of - 10.0 m below chart datum. The 45m wide and - 7.3 m deep channel was also proposed to be widened to 75m with a depth of - 8.5m. The existing harbour wall is founded to a level of - 8.98 m.



▲ *Typical Flow Pattern During EBB*

Since the proposed deepening would extend beyond the foundation level of existing structure, new berths on marine piles extending beyond –10m depth of foundation protruding into sea waters by about 20m were also proposed. In order to ascertain the likely changes in the flow and siltation patterns due the proposed developments, the studies were carried out at CWPRS.

The site-specific field data in respect of tidal currents and silt charge covering three consecutive tides was collected by CWPRS for typical spring tide near the harbour wall proposed berths. The model studies were carried out by using existing physical model (scales- 1/400H, 1/80V) and the mathematical model TELEMAC-2D. The studies on the physical model suggested the general flow pattern and the changes due to construction of any structure. The siltation patterns or any changes in the morphology due to the proposed developments were evolved by using mathematical model. The studies indicated that due to the deepening and widening of the berthing area and channel, the flow patterns would be marginally modified but would result in change in the siltation pattern. The sedimentation studies indicated that after the proposed dredging the silt deposition rate near the proposed berths would be as high as 4.0m/annum and the channel would also experience a silt deposition rate of 2 to 3 m/annum. The additional quantity of deposition near the proposed berths and channel would be about 1.4 lakh cum/annum.



▲ *Annual Silt Deposition Pattern for Proposed Condition*

EXTENSION OF JETTY AT KARANJA, MUMBAI

Karanja jetty (Pier) is situated on the north bank of Dharamtar creek. This creek joins Mumbai harbour on east side of its entrance. The existing jetty of length of 237 m and width of 17 m is mainly used for passenger traffic across the creek. In order to facilitate the passenger traffic across the creek during low water, it was proposed to carryout soft and hard dredging. Maharashtra Maritime Board (MMB) has proposed to extend the existing jetty by another 100 m to 150 m to bring down the cost of maintenance dredging in this area and to get the sufficient draft at low water. The hydraulic model studies for extension of Karanja jetty were undertaken at CWPRS. The field data required for the studies in respect of tides, tidal currents, silt charge and bed samples were supplied by MMB.

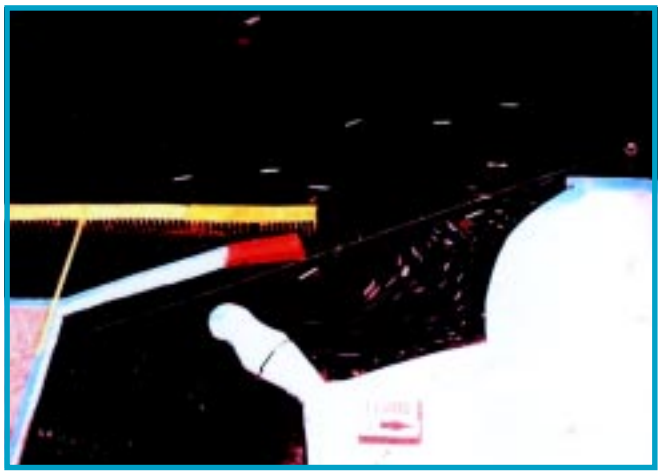
The studies were carried out by using existing Mumbai harbour tidal model (scales : 1/400 H, 1/80 V). The studies indicated that near the proposed jetty head, the flood flow would be at an angle of 100^0 N and the ebb flow at an angle of 265^0 N.

It was recommended to extend the present jetty in line with existing jetty by upto 175 m so that it would come to zero meter contour. The jetty head could be "L" shape or "T" shape to be aligned at 110° N. The jetty (approach and landing) was recommended to be built on piles so that the prevailing flow pattern would not be disturbed and the siltation also would not be aggravated in any way. The length of the jetty head would depend upon the number of vessels to be berthed. Assuming that the passenger vessels would require draft of 1.5 m, a dredged depth of -2m was recommended for vessels to approach jetty even during low water. The width of channel was suggested as 75 m and the total length of the channel was worked out to be 750 m. The capital dredging for the recommended proposal would be about 1.45 lakh cum whereas the annual maintenance dredging requirement was estimated as 45,000 cum.

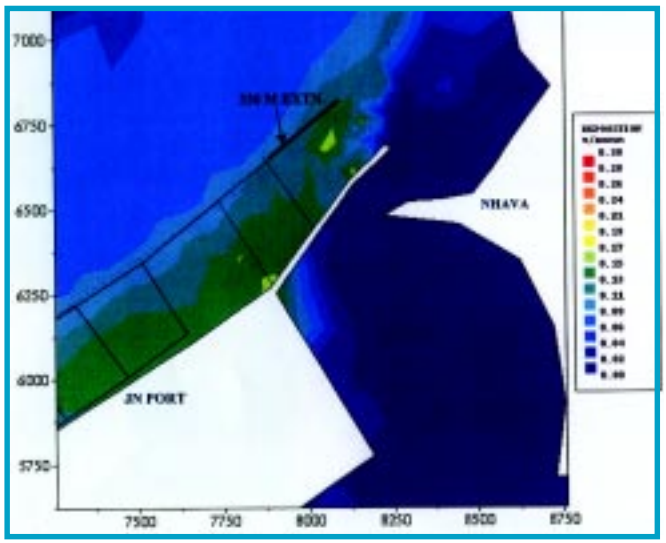
EXTENSION OF CONTAINER (NSICT) BERTH AND OTHER FACILITIES AT JAWAHARLAL NEHRU PORT, MUMBAI

The Jawahar Nehru Port (JNP) is a major port situated on east of Mumbai harbour specialized in handling of containers. The port had five container berths of total length 1280 m and three bulk berths of total length 712 m. M/s P&O Australia is operating two container berths on the north called as Nhava-Sheva International Container Terminal (NSICT). Under the expansion plan of this terminal, there is a proposal of extending the berths on the north and also for providing shore based facilities such as container stacking yard by reclamation in the inter-tidal zone of Nhava creek. The studies for the proposed expansion scheme were carried out at CWPRS including seismic reflection survey. In the other development plan, JNP envisaged to commission a Ro-Ro berth for handling car carriers inside the basin located between the bulk and container berths. The maneuvering of car carriers to the Ro-Ro berth was required to be carried out through an entrance with an effective restricted width of 193.08 m. Studies were done at CWPRS for maneuvering two car carriers viz. M.S. Pioneer Racer and M.V. Asian Leader.

The studies for the extension of the NSICT berth, guide bund and reclamation were carried out on the existing Mumbai harbour physical tidal model (scales: 1/400H, 1/80V) for flow conditions. Mathematical model studies were carried out by using TELEMAC-2D software for studying the effects of extension of guide bund and of proposed reclamations on the siltation pattern. The Nhava-Sheva creek meets the Elephanta deep on northern end of container berth. The studies indicated that under the existing conditions, the part of ebb flow from Nhava creek hits about 150 m of the proposed 300 m long extended berth on piles.



▲ *Flow Field During Flood with Extension*



▲ *Annual Silt Deposition Pattern with Extension*

Therefore, about 150 m of theproposed berth would be affected by the cross flow and eddies. In order to avoid this cross flow, the extension of the existing guide bund would be necessary. Based on the studies, it was recommended that the NSCIT berth may be extended by 330 m on the north in line with existing berths with an optimum guide bund extension of 160m oriented 10° clockwise with respect to the alignment of existing guide bund. The extended bund and berth would not affect the flow conditions at the facilities of ONGC located on Nhava Island and the developments as envisaged in the master plan. The alignment of the reclamation proposed in Nhava Creek was modified and a smooth line of reclamation was suggested to guide the flow suitably in the creek. A piled approach connecting the proposed berth and guide bund that would not obstruct the flow, was recommended to provide access for the proposed berth.

For the Ro-Ro berth, the mathematical model studies for maneuvering of car carriers into the basin were carried out using the software NAVIGA developed at CWPRS. Several maneuvering trials were conducted for various combinations of environmental conditions. The studies indicated that the vessels M.V. Asian Leader (DWT 7014 tons) and M.S. Pioneer Racer (DWT 11311 tons) exhibited similar pattern of trajectories in maneuvering. In view of the narrow entrance to the basin, tug assistance during berthing maneuver was recommended.

For extension of NSCIT berth and additional facilities in JNP, the continuous information about subsurface strata, including rock topography was needed. The high resolution underwater seismic reflection survey using single channel frequency modulated 'Chirp' system was carried out along seven traverses totalling 2 line km at the proposed site for extension of quay line. The continuous subsurface geological information inferred from the survey would be used in deciding the dredgeability of the subsurface strata. The rock levels evaluated by reflection survey would also help in deciding the level and in designing the foundations for extension of container berth and guide bund. It was inferred from the results of the survey that the depth to seafloor with respect to chart datum vary from - 1.0 m to - 15.1 m. The same for basalt rock was evaluated to be between - 4.8 m & - 22.1 m.

DEVELOPMENT OF TRAINING WORKS AT VARSOLI CREEK IN ALIBAG, MAHARASHTRA

In order to promote the welfare of local fishermen and to provide adequate landing facilities, Government of Maharashtra contemplated to improve navigational conditions at the mouth of Varsoli Creek at Alibag. In absence of suitable training works, the conditions at the entrance of Varsoli creek were hazardous for navigation due to heavy breaking of waves and presence of inadequate depths. The average tidal range at Varsoli is 4.5 m and the low water line is about 500 m away from the coastline. The local fishermen were able to ply their crafts only during high stages of tide and consequently, they were loosing considerable time for landing their catch. The studies were undertaken at CWPRS to evolve suitable training works in order to improve navigational conditions at the entrance of Varsoli creek.

The studies were conducted by using 1-D mathematical model to simulate the hydrodynamic conditions. Analysis of prototype data indicated that due to shallow depths, tides were not propagating properly inside the creek. The average velocity at the entrance was about 0.20 m/sec. On the basis of studies conducted, two parallel groynes of 500 m length each at 125 m centre-to-centre spacing enclosing a navigational channel of 50m bottom width, were recommended to prevent lateral entry of sediments and to provide adequate wave tranquility in the navigational channel. Dredging of the navigational channel to (-)2.0 m was recommended to facilitate proper tidal propagation and to enable the fishermen to land their crafts even during the low stages of tides. In future, a sand trap of size 200 x 100 m dredged to (-)3.0 m level was suggested to be provided within the groynes for arresting littoral material.

WAVE DATA COLLECTION AND MATHEMATICAL MODEL FOR WAVE TRANSFORMATION AT JAWAHARLAL NEHRU PORT, MUMBAI

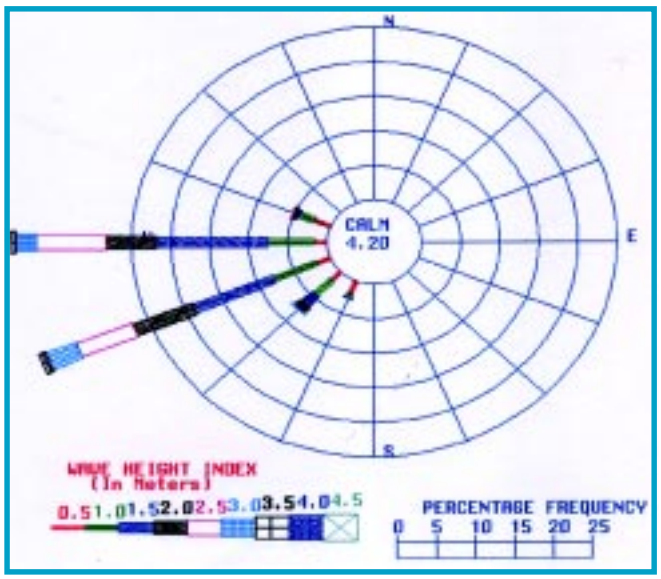
Under the expansion plans of Jawahar Lal Nehru Port (JNP), there is a proposal for deepening and widening of main navigational channel to enable entry of fourth & fifth generation container vessels irrespective of tidal conditions. The depth in the main channel and JNP channel is currently maintained at -11.0 m below Chart Datum (CD). This channel is now proposed to be deepened upto -16.0m at the entrance and -13.0 m near the port area with varying depths in different reaches of the channel. Studies were conducted at CWPRS to obtain wave conditions along the channel and also in the JN Port area due to the proposed development. In this regard, the prototype wave data were collected in the sea simultaneously at the entrance to the estuary and near JNP approach channel and a mathematical wave model was setup for wave transformation studies.

A signal receiving station shore based Digital Wave rider Receiving (DIWAR) unit was set up with the deployment of two wave rider buoys having online monitoring computer system. The receiving station consisted of online monitoring computer system. The inner wave rider buoy of 70cm diameter was deployed at 10m depth and the outer wave rider buoy at 12m depth. The wave data was collected for 20 minutes at every 3-hour interval during which the wave climate is assumed to be stationary. The data recorded by these wave rider buoys from March 2003 to September 2003 were analyzed which provided wave statistics for various wave parameters viz. maximum wave height, corresponding wave period, significant wave height of a wave train and corresponding average wave period. From the analysis of daily record, the maximum wave height (Hmax), maximum significant wave height (Hs) and maximum average wave period (Tz) recorded by the Wave rider buoys in each month from March to September 2003 were obtained. The analysis indicated that the maximum wave height recorded at the entrance to the estuary i.e. at the outer wave rider buoy in the south – west monsoon (June to September) was1.9m in June, 2003 while in the interior of the port area, the maximum wave height recorded at inner wave rider buoy was 1.1m in July, 2003.

The simultaneous wave data obtained from the wave rider buoys deployed in the estuary and the wind data were used for calibration of the mathematical model for wave transformation, to predict the wave conditions for different stages of development in future. Wave transformation studies were carried out for different combinations of incident wave heights, wind speed and wind direction. The studies indicated that wind has a significant effect on wave growth in the Mumbai estuary. Therefore wind speed was used as a calibration parameter in the model by selecting proper wind speed for a particular incident wave height. The wind speeds to be considered for different input wave conditions for simulating wave propagation in the JNP area in different months were established. Based on the findings of above studies, a mathematical model has been developed for wave transformation in Mumbai estuary especially along the approach channel to JNP and nearby areas.

OPTIMISATION OF LAYOUT FOR DEVELOPMENT OF ALL WEATHER PORT AT REDI, SINDHUDURG DISTRICT, MAHARASHTRA

Maharashtra Maritime Board (MMB) has a proposal to develop an all weather port at Redi village in Sindhudurg District, Maharastra, for export of iron ore and other commodities. In the first stage of development, two berths for 40,000 DWT ships and one berth for 20,000 DWT ship were envisaged. In the second stage, one additional berth for 20,000 DWT general/liquid cargo was proposed. Also considering the future requirements, it was proposed to provide for 100,000 DWT Bulk carriers and 4000/6000 TEU container ships in the third stage. M/s Consulting Engineering Services (CES), New Delhi, have carried



out the techno-economical feasibility study and they recommended south breakwater of 2800m length and north breakwater of about 250m length for the final stage of development. Mathematical model studies were carried out at CWPRS by using MIKE-21 and OUTRAY models for optimization of the layout of the proposed harbour considering the site conditions, tidal flow and wave propagation. Field data regarding tides, currents, sediment concentration required for conducting mathematical model studies were provided by MMB. The nearshore wave conditions, obtained by the OUTRAY model indicated that the predominant wave directions of wave approach in 12 m depth are WNW, West, WSW and SW. The recommended harbour layout consisted of an offshore breakwater of length 1960 m and three berths of 705m length in stage I development. In the second stage, the fourth berth of 215 m length was proposed on the lee side of the offshore breakwater.

The possibility of providing a breakwater protection to the existing barge jetties 1, 2A and 2B was also considered. Since the loading/unloading operations between the mothership and the barges would not be possible in the open sea during monsoon season, it was felt that providing breakwater protection would not help in operations round the year. An additional jetty 2C adjacent to the existing jetties 2A/2B was suggested. In order to meet immediate additional requirement, it was recommended that the jetty 1 could be renovated and made operational.

ALIGNMENT OF JETTIES AT RAJAPURI, JANJIRA FORT, AGARDANDA AND DIGHI IN RAJAPURI CREEK, MAHARASHTRA

Maharashtra Maritime Board (MMB) has proposed to develop inland water transport facilities at Rajapuri, Janjira fort, Dighi and Agardanda situated in Rajapuri creek on the west coast of India. Studies were undertaken at CWPRS to examine wave transformation and propagation and currents for recommending alignment of the jetties and to estimate the number of operational days at the proposed sites of development.

Offshore wave data reported by the India Meteorological Department from 1968 to 2001 were utilized for the studies. OUTRAY model was used for computation of wave transformation from deep waters to the entrance of Rajapuri creek. These studies indicated that the predominant directions of wave approach in -5m depth at the entrance of the creek were from NW, WNW, SSW and SW.

Tentative alignments of the jetties for the ferry terminals of Janjira and Rajapuri were decided based on the available current meter and float track observations. In order to find suitability of the alignment from the wave considerations at the jetty face, studies were carried out for simulation of wave propagation in the creek by using STWAVE model. The permissible limit for the passenger ferry terminal for desired wave tranquility was considered as 0.3m.

Studies with STWAVE model indicated that at Janjira ferry terminal, waves would approach the jetty predominantly at an angle 340^0 N and the average wave height near the terminal would be less than 0.3m. Hence, jetty operation throughout the year would be possible. The terminal at Rajapuri was much more exposed to waves in comparison to the terminal at Janjira. Waves would approach the proposed jetty location at Rajapuri at an average angle 245^0 N. The wave height near the terminal was seen to be more than 0.3m for about 110 days. Thus the operational days at the jetty would be limited to about 255 days in a year.

▲ *Wave Height Contour Plot in Rajapuri Creek for Waves from NW Direction*

The proposed site of development at Agardanda was exposed to high waves from NW and West direction. It was observed that waves would approach the proposed site at an average angle of 295^{0}N and wave heights would remain below 0.3m for about 245 days in a year. At Dighi, the waves approached the proposed site at an angle 345^{0}N and wave heights would remain below 0.3m throughout the year. Thus, the proposed terminal location at Dighi would be well protected from wave attack for all the incident wave directions.

At the exposed locations of Rajapuri and Agardanda, the detailed studies were recommended to evolve length and alignment of breakwater, for operation at jetties throughout the year.

DESIGN OF BREAKWATER AND LAYOUT FOR MANDWA PORT, MAHARASHTRA

Harbour Engineering Division of Govt. of Maharashtra has proposed to upgrade the passenger landing facilities at Mandwa port near Alibagh at the entrance of Dharamtar creek. The existing jetty, which is old and in deteriorated condition, is exposed to direct attack of waves without any protection. The following developments were proposed at Mandwa port :

- Construction of a suitable breakwater to provide desired wave tranquility for safe berthing of the boats

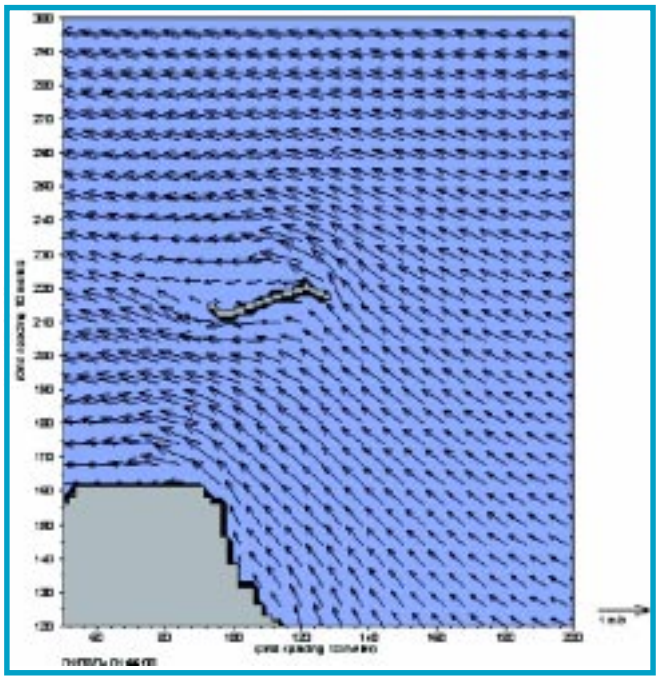
- Construction of the second jetty of length 40m at a distance of 60m and parallel to the existing jetty

Studies were conducted to evolve the optimum alignment and length of the proposed breakwater and extension of the existing jetty to new finger jetty. Studies were also conducted to evolve the suitable cross section for the breakwater.

The mathematical model studies were carried out by using MIKE-21 and STWAVE models. The prevailing tidal levels, tidal currents and wave heights were simulated. The hydrodynamic studies and wave tranquility studies were carried out for different breakwater layouts. Simulations were carried out for predominant waves incident from WNW, W and WSW directions. The studies indicated that under the existing condition, wave heights near the jetty were of the order of 2.0 m to 2.5 m for an incident deep-water wave height of 4m and waves approached from 300^0 N direction.

The hydrodynamic studies carried out for existing condition indicated that the tidal currents were almost parallel to the jetty and there would be no tidal circulations at the jetty location. Based on the prevailing tidal conditions, the approach with piled structure to the proposed jetty was recommended in line with the existing approach, to minimize obstruction to the flow.

The breakwater length of 360 m was recommended to provide desired wave tranquility at the jetty with minimum obstruction to the tidal flow. From the frequency distribution of wave height and wave direction off Mandwa during entire year, it was observed that wave heights in the area near existing as well as proposed jetty would remain within the assumed permissible limit of 0.3 m for about 350 days in a year.



The studies for design of the breakwater section were carried out in the Wave flume having Random Sea Wave Generating facility for predominant design wave conditions. The trunk section with 8t tetrapods on the armour and the roundhead sections having 10 t tetrapods at 1:2 slope, were recommended for the proposed breakwater.

WAVE TRANQUILITY AND LITTORAL DRIFT BEHAVIOUR FOR PROPOSED FISHERIES HARBOUR AT KULAI, MANGALORE

The fishermen at present are using the existing beach located along the northern and eastern parts of New Mangalore Port basin. In order to avoid interference of the fishing crafts with the port traffic and to facilitate development of the western dock arm for providing additional berths, it is proposed to provide a separate fisheries harbour outside the port basin. Out of the three alternative locations on the northern side, the site near Kulai at a distance of about 5 km from the port was finalized. Conceptual layouts were suggested by CWPRS considering the prevailing wave climate and the orientation of the shore. A detailed layout, which would consist of two breakwaters of 750 m and 320 m length with reclamation of 60,000 sqm, was suggested by Central Institute of Coastal Engineering for Fisheries (CICEF) for studies.

The hydraulic model studies for wave tranquility were carried out at CWPRS on a 1/100 GS model having facility for unidirectional random wave generation and multi channel wave data acquisition system. The studies were carried for predominant incident waves corresponding to monsoon (June to September) and non-monsoon (October to May) seasons. With the help of studies, the lengths of the north and south breakwaters were optimized to 675 m and 255 m respectively with reclamation of 30000 sqm with entrance facing south-south-west direction. The layout was also checked for long period wave oscillation by desk studies. A spending beach along the northern edge of the basin was recommended for dissipation of short period waves. The siltation in harbour due to tidal exchange was also estimated negligible due to small tidal prism.

Based on available data and reports for Mangalore region, littoral drift rate of one lakh cum/year towards south and 10000 cum/year towards north was considered for studies.

▲ *View of Tranquil Harbour for Incident Waves from SW Direction*

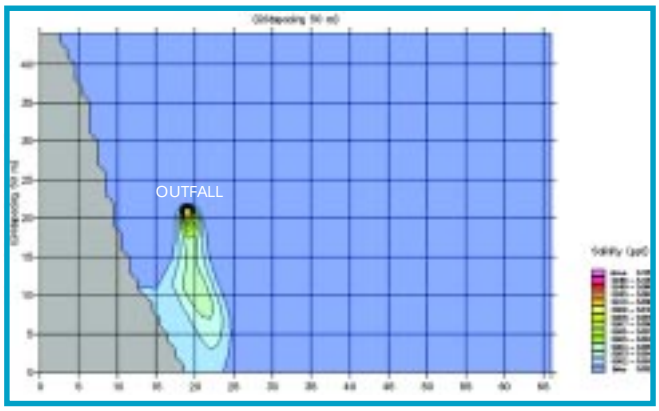
Studies for assessment of littoral drift carried out by injecting walnut shell granules indicated that during the initial stages, the material moved towards the south due to littoral longshore current and accumulated between the north breakwater and the coastline forming a fillet. Continuous injection indicated that after completion of the fillet formation, the material would move along the northern breakwater into deeper region. This indicated that the siltation in the harbour due to littoral drift material would be minimal even after fillet formation. Desk calculations indicated that a period of atleast 6 years would be required for the complete formation of the fillet.

SEA WATER INTAKE AND OUTFALL SYSTEM FOR DESALINATION PLANT FOR CHENNAI PETROLEUM CORPORATION LIMITED, CHENNAI

Chennai Petroleum Corporation Limited (CPCL) proposes to install 5.8 MGD seawater desalination plant at Ennore, North Chennai to cater for its existing refinery and the expansion requirements. The proposed desalination plant is based on Reverse Osmosis process. The proposal includes a seawater intake and outfall system in the Bay of Bengal. It is proposed to withdraw 12 MGD of seawater from the intake and discharge 6 MGD of effluent at the outfall. The salinity of the discharged water would be 63 ppt, the ambient salinity being 32 ppt. The water drawn from the desalination plant is required to be discharged at suitable location in the sea such that saline recirculation would be avoided at the intake location. The criteria for recirculation was considered as 0.1 ppt above ambient.

Mathematical model studies were carried out at CWPRS for determining suitable locations of intake and outfall for the proposed desalination plant. The studies were carried out using CORMIX model for near field dispersion and MIKE21 model for far field dispersion of saline water. The intake was selected in 8m depth of water, at a distance of 250 m from the shoreline. The studies were carried out for three alternative locations of outfall at 500 m, 750 m and 1000 m from the shoreline. The tides at the site are semi-diurnal with low amplitude. The maximum spring tidal range is 1.3 m while minimum neap tidal range is 0.25 m. The currents in the sea are predominantly towards north during the months of February to September with maximum current speed of the order of 0.5 to 0.6 m/s. The currents are towards south during the months of October to January with maximum magnitude of 0.1 m/s.

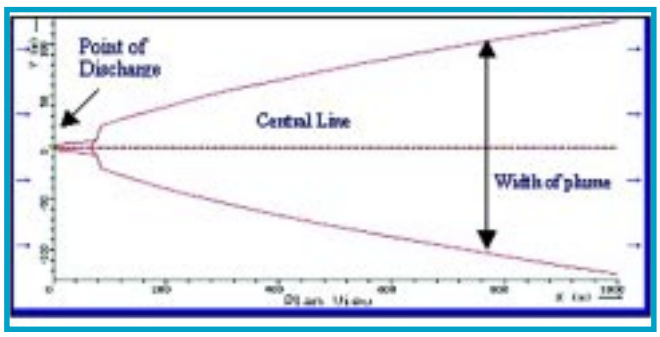
From the MIKE-21 model studies, it was observed that the outfall location should be at a distance 750 m from the shoreline.



▲ *Salinity Plume for Outfall Located at 500 m for Southerly Currents*

The saline water discharge from the outfall is negatively buoyant i.e. heavier than ambient water. The CORMIX model studies showed that the effluent after dilution would sink to the bottom and then would move along the seabed resulting in less dilution of the effluent. The port opening should be kept vertically upward, which gives higher dispersion as compared to the horizontal port.

From the studies, it was seen that the outfall at a distance of 750 m from shoreline with port opening of 0.15 m diameter pointing upward would be suitable to achieve maximum dilution so that the recirculation would be avoided.



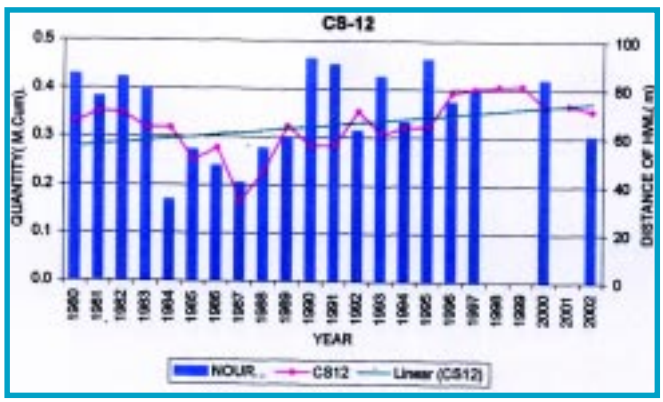
▲ *Dispersion Pattern of Salinity from CORMIX Model*

ANALYSIS OF BEACH PROFILES AT NORTH OF VISAKHAPATNAM PORT TO ASSESS EFFECTS OF LONG TERM NOURISHMENT, ANDHRA PRADESH

East coat of India is characterisized with large littoral drift. Any manmade constructions such as breakwater, intercepts the littoral drift resulting in accretion on the updrift side and erosion on the downdrift side unless adequate care is taken to bypass the accreted sand. The outer harbour of Vishakhapatnam port was commissioned in 1976. On the south side of Visakhapatnam outer harbour, the net littoral drift of the order of 0.7 Mcum/annum prevails in northern direction. The sand trap of about 0.6 Mcum capacity located immediately north of the gap between the western tip of south breakwater and Dolphin's nose headland, gets effectively filled during southwest monsoon. The sediments in sand trap are normally dredged by trailer suction hopper dredger (TSHD) during pre/post monsoon season and bypassed on the downdrift northern side through a land based pipeline. This system made use of powerful dredge pumps of TSHD for pumping the sand in a tranquil outer harbour basin for positioning the dredgers. This system had been evolved based on comprehensive model and desk studies at CWPRS.

▲ *View of Northen Coast and Beach Road*

To evolve the optimum disposal strategy for sand bypassing, the analysis was carried out of prototype data of 23 years (1980 to 2002) of beach profiles on the north coast as well as dredging and disposal quantities. To evolve the beach response of the immediate northern stretch in relation to the on-shore sand nourishment through the pipeline, the information regarding the critical indices like position of High Water Line (HWL), Low Water Line (LWL) and slope between HWL and LWL was derived for all the cross sections which were being monitored by Port Authorities regularly every month. All the parameters were responding in agreement with the corresponding nourishment rates. The analysis indicated a very delicate balance between the nourishment quantity and beach profiles for dynamic equilibrium. It was recommended by CWPRS after detailed analysis that the optimum beach nourishment rate of about 0.4 Mcum was required to retain the existing beach width. The cumulative effect of lower/nil nourishment rates in successive years lead to significant erosive trends as observed in the long term analysis. The success of the maintenance of the beach upto about 3 km stretch north of the outer harbour i.e. upto Waltair point, without any damage to the adjacent beach road and properties can be attributed to the efficient system of protected sandtrap and land based pipeline enabling onshore beach nourishment near HWL. Considering the delicate balance being maintained, it was advised that any changes to be made in the disposal activity would need cautious planning.



EXTENSION OF SOUTH BREAKWATER AT PARADIP PORT, ORISSA

Paradip Port, one of the major ports of India, is situated on the east coast in Orissa state. It is a lagoon type of harbour commissioned in 1966. The Paradip Port presently handles vessel upto 80,000 DWT for different types of cargo. The port expanded the facilities by constructing an oil berth near the root of the north breakwater to cater to Very Large Crude Carriers (VLCC) upto 2,50,000 DWT capacity. Widening of the approach channel to 240 m width at bottom and deepening to a depth -19.2 m below CD are required in order to cater for these vessels. With such development, the wave disturbances in the approach channel are expected to increase with the requirement of longer stopping distance for the ships entering the channel. With due consideration to above, the port authorities proposed to extend the south breakwater by about 700 m for providing adequate tranquility in the approach channel.

The round head and some portion of the existing south breakwater of length 1217 m was damaged in the past due to the fury of cyclones in the past and in particular, the recent 'Super Severe Cyclone' of October 1999. As an immediate measure, out of total 700 m proposed extension of south breakwater, initial extension of 100 m was carried out with its alignment parallel to approach channel as a part of restoration of the damaged south breakwater. Further extension of south breakwater was to be carried out in stages after determining its effect on the wave tranquility and siltation in the harbour basin. Studies were carried out on existing physical wave model (scale: G.S.1/125) with facility to reproduce waves from two predominant wave directions viz. East-South-East and South which represent incident waves during North-East and South-West monsoons respectively.

The studies for extension of length of south breakwater for different alignments indicated the adverse effects in respect of wave disturbance, siltation in the approach channel and further erosion of the northern shoreline.

The model studies with the island type of breakwater of length 750 m located at a distance of 700 m from the tip of the south breakwater indicated that it was more effective in providing better wave conditions in the lee side, in the approach channel and also on the seaside of the north breakwater while waves are from ESE direction or south direction. The island breakwater would also provide much better solution to the problem of stopping distance for the ships, siltation in approach channel, effective trapping of the littoral material in the sand trap, dredging of sand trap, which can be used for nourishment of northern shoreline.

DEVELOPMENT OF PORT AT ANDROTH, LAKSHADWEEP

Lakshadweep, the Union Territory of India, is a group of 36 islands in the Arabian sea. Among these islands, only 10 islands are inhabited and Androth is one of the major islands of Lakshadweep. The existing Androth port is being used for import of construction material and food grains and export of copra, coir and fish. The existing port consists of a RCC jetty to facilitate berthing of small craft and pablos and 160 m long berth on the leeside of existing breakwater of 530 m length, for berthing of inter-island vessels. Andaman Lakshadweep Harbour Works (ALHW) proposed to develop Androth as an all weather port and improve the berthing facilities by constructing a 700 m long breakwater under stage-III development with a berth of 200 m length on its lee side. In this regard, earlier CWPRS evolved the layout of the extension of breakwater based on wave tranquility studies. During the year, mathematical model studies using MIKE-21 software for simulating hydrodynamics and sediment movement were conducted at CWPRS in view of the proposed extension of breakwater. The studies were also conducted using a mathematical model MORMOT to ascertain the behaviour of moored ship.

Initially the studies were carried out for existing condition for the breakwater length of 530 m constructed up to stage-II development. The study showed that the tidal currents were almost parallel to the coast and velocities were of the order of 10 cm/s. Typical reversal of flow during flood and ebb conditions were observed. With a proposed breakwater extension of length 700 m, it was seen that the velocities in the harbour area were reduced and the flow would be diverted away from the coast with marginal increase in velocities near the tip of breakwater.

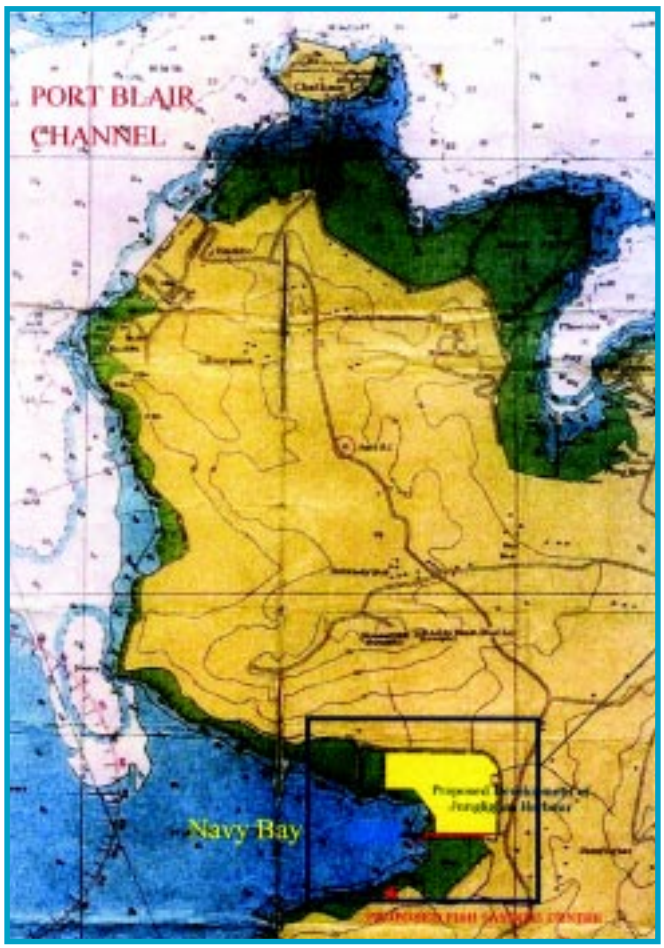
The studies for simulating sediment movement showed that the sediment influx from the east side during ebb approached the harbour but was diverted along with the flow round the breakwater. Thus, the extension of breakwater by 700 m would not cause significant changes in the flow conditions and sediment would get diverted along with the flow to the offshore region. No significant siltation was expected in the harbour due to the proposed extension of the breakwater by 700 m, as sediment concentrations in the region were also quite low.

The behaviour of moored ships was simulated at the proposed 200 m long berth for all the vessels belonging to the Union Territory of Lakshadweep including the one under construction with a length overall of 157 m. The studies indicated that pneumatic fenders of size 1.3 m x 2.5 m would be suitable for the jetty provided the berthing velocity of the ship under construction, the biggest of all the vessels in less than 15 cm/s and that of other ships, less than 25 cm/s. The studies also indicated that the moored ships were found to be safe to operate at the proposed berth for wave heights up to 1.0 m with prevailing beam winds of 10 m/s. The mooring line tensions and fenders deflections were also found to be within safe limits for all vessels.

DEVELOPMENT OF JUNGLIGHAT HARBOUR AT PORT BLAIR, ANDAMAN

The Andaman Lakshadweep Harbour Works (ALHW) has proposed to develop Junglighat Harbour in Navy Bay area of Port Blair tidal channel. The first stage of development of Junglighat harbour would consist of the following:

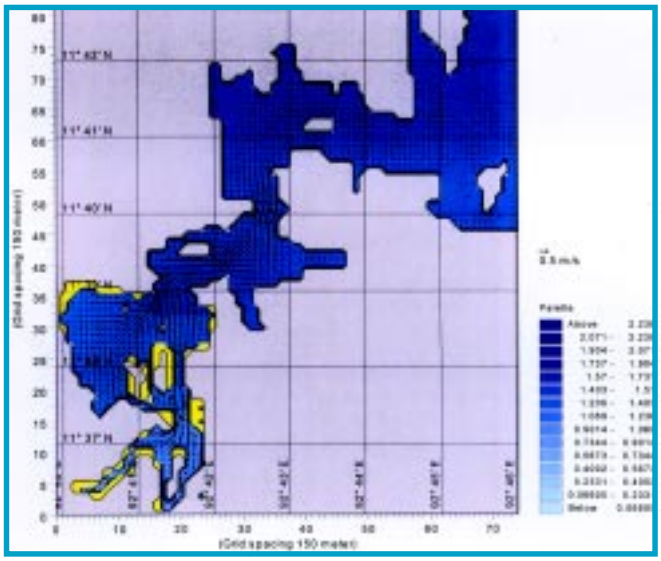
- Construction of 420 m length of boulder bund
- Reclamation of 10 Ha area
- Dredging of 0.25 Mcum and using the same for reclamation



In the second stage of development, extension of approach jetty 175 m x 9 m and three numbers of finger jetties are included. Mathematical model studies using MIKE-21 were conducted at CWPRS to examine the changes in hydrodynamics and sedimentation / erosion due to the proposed development.

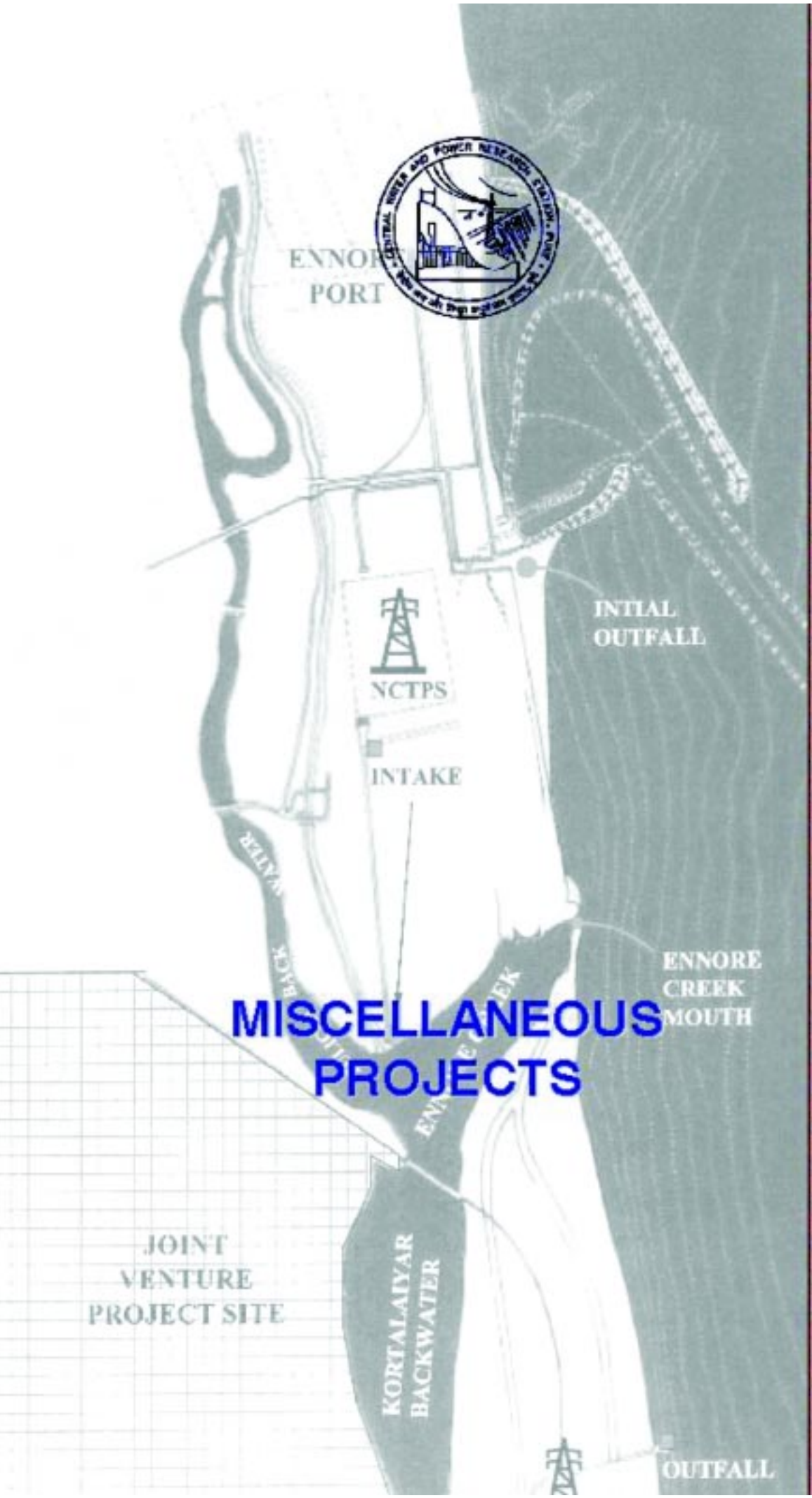
Initially, the hydrodynamic studies were carried out for existing condition. The study showed that the tidal currents were dominant in the tidal channel. However, the bay was free from tidal circulations and the velocities in the bay were of the order of 10 cm/s. Typical reversal of flow in the tidal channel during flood and ebb conditions were observed.

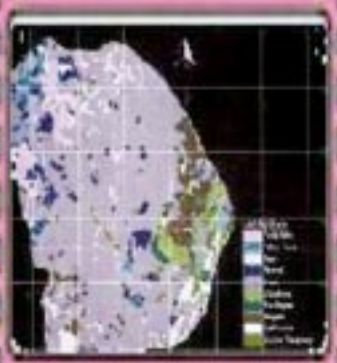
The hydrodynamic studies were also conducted with proposed development considering the construction of solid approach bund, reclamation to +3.5m and dredging to -6 m in the bay for inland transport of the vessels. The studies indicated that the velocities in the harbour area would marginally increase at the entrance to bay. There would be no significant changes in flow conditions due to proposed development.



The studies for sediment movement showed that the sediment concentration coming from the north side during flood was very less and the sediment concentration measured in the tidal channel was also quite low. Moreover, the flow would get diverted to west side along the main channel. Thus, there would be no significant sedimentation/erosion in the proposed harbour.

MISCELLANEOUS PROJECTS



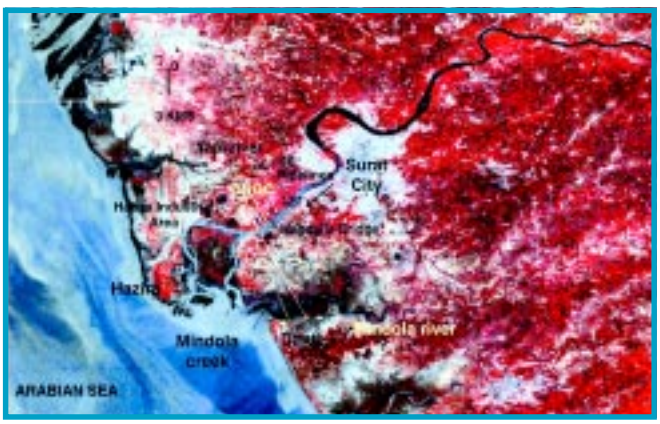


STUDIES REPORTED : MISCELLANEOUS PROJECTS

STUDIES FOR PROTECTION OF GAS PIPELINE OF ONGC IN MINDOLA CREEK, GUJARAT

The Oil and Natural Gas Commission (ONGC), in the year 1985, had commissioned natural gas pipelines carrying gas from offshore platform at south basin (near Bombay High) to Hazira terminal. One of the gas pipeline crosses the Mindola creek near village Danti and travels towards ONGC gas processing plant at Hazira after crossing Tapi river. During first post construction inspection of the pipeline in 1995 in the Mindola creek, it was noticed that in the deep channel portion the gas pipeline was having a free span of about 140 m due to scour of the bed material below the pipeline. In the year 1999, vibrations of the gas pipeline in the free span portion were noticed. In order to arrest these vibrations, ONGC provided four supports to the pipeline at an interval of about 35 m in the free span portion. In spite of these supports, in line and cross flow oscillations of the pipeline were reported in the year 2000 and 2001. The studies were conducted at CWPRS to suggest protection measures for the pipeline in following two stages :

- Site inspection to suggest immediate measures to arrest vibration
- Conduct mathematical model studies to predict extreme flow conditions around the pipeline in Mindola creek and suggest suitable long term measures.



The CWPRS officers carried out first site inspection in May 2002. It was concluded from site inspection that the basic cause of oscillations of the pipeline was the formation of free span of about 105 m due to development of gaps of 5 cm to 25 cm below support No.1 and 2 from the left bank of the Mindola creek. These gaps were created due to damage of secondary support below the pipeline. This free span of 105 m was much more than the design critical free span of 43 m for the reported maximum velocity of 1.8 m/s. The pipeline was vibrating even with flow velocities lower than the design velocity whenever the frequency of vortex shedding around the pipeline was equal to the natural frequency of the pipeline. CWPRS suggested immediate measures such as closure of the gaps below the pipeline with grout bags ensuring full contact, provision of the additional support between south bank and the support no.1, loading of the pipeline near support with sand or grout fill geobags to compensate for loss of weight due to damage of concrete coating over pipeline. The immediate measures were effective.

CWPRS further carried out 1-D and 2-D mathematical model studies to predict extreme flow conditions in the Mindola creek near ONGC pipeline. Mindola creek reach from mouth to about 20 km upstream was simulated in 1-D model and local reach of 2 km upstream and downstream was simulated in 2-D

model. These studies concluded that the maximum velocities of the order of 1.8 m/s to 2.0 m/s would prevail around the pipeline near Mindola creek crossing. As a result of these flow conditions, the existing river bed at the level of -6.0 m could get eroded to a level of -8.6 m. The possibility of further bank erosion could be there due to the predicted high velocities as well as due to shifting of the deep channel course as noticed from the study of satellite imageries and old toposheets of this reach. From comparative study of various measures for aspects such as cost, period, ease of execution, effect on the flow conditions and river morphology, the long term measure of special shape geo bags filled with cement grout was recommended to be placed on and around the pipeline and existing large supports below pipeline such that the pipeline would not be subjected to inline and cross flow oscillations. Suitable bank protection works to arrest the erosion of the left bank near the pipeline crossing were also suggested.

STUDIES FOR KUDREMUKH IRON ORE COMPANY LIMITED, KARNATAKA

Kudremukh Iron Ore Company Limited (KIOCL) is a public sector undertaking of Government of India under the Ministry of Mines. The KIOCL has mining leased area of 4630 ha on the banks of river Bhadra, in Karnataka. The ore is extracted by surface mining technique and tailings generated during the beneficiation process of the iron concentrate are being disposed in the valley space created by construction of earth dam on Lakya Hole river near the mine so that, the downstream population is not affected. In order to control sediment flow from mining area in to Bhadra river, KIOCL has constructed two Pollution Control Dams (PCDs) on two streams passing through the mining area.

The Honourable Supreme Court of India has given directive to close the mining in December 2005. As per the guidelines of the Indian Bureau of Mines (IBM), a mine closure plan was to be prepared before closing the mines. Various aspects like physical, biological and socio-economics of the mining and surrounding area are covered by these guidelines. The task of preparations of mine closure plan was entrusted to Indian Council of Forestry Research and Education (ICFRE), Dehradun. On request of ICFRE following studies were taken up by CWPRS, which form an input for preparation of final mine closure plan.

Slope stability of mine and Hill slopes

The actual mine area of KIOCL is 925 ha. The three hills in this area where mining operation is in progress were studied. The ore that occurs in the mine is in Banded Magnetic Quartzite (BMQ), in soft-weathered ore, intermediate hard-weathered ore and transitional hard-weathered ore strata. The BMQ is followed by chlorite schist, coarse, grained amphibolite and hornblende schist. The stability analysis of mine slopes was carried out by the desk studies based on the properties of material taken from the report by National

Institute of Rock Mechanics (NIRM), Kolar Goldfields, Karnataka. The hill slope cross sections were analyzed by slip circle analysis based on Bishop's modified method of analysis. Slopes were modified for achieving factor of safety more than 1.5. In modified slopes, bench width of 30 m height flume and slope of 1:2 was adopted. The long term slope stability was carried out for dry season and monsoon season with heavy rainfall. It was found from the studies that the critical slip circle passes through toe of the bench giving factor of safety of 1.8 to 1.9. It was recommended that proper drainage arrangement should be made across the benches, pore pressure and movement should be monitored and slopes should be inspected regularly to ensure stability of slopes in mined area.

Stability of Lakya Earth Dam : The Lakya dam is 1500 m long with maximum height of 100 m. Downstream method of raising the dam height has been adopted and earth material instead of tailings is used as construction material. These are the positive aspects in static analysis of stability of dam. The dynamic analysis using its specific earthquake loading was conducted by CWPRS. The results indicated that the dam would not undergo liquefaction and deformation more than 5% at any location and hence is safe against site specific ground motion. It was recommended that post mine closure stability of the dam should be ensured by routine monitoring and maintenance.

Hydrological studies

The hydrological aspects studied for Kudremukh Iron Ore Mine included estimation of extreme flood for Lakya dam, estimation of sediment from the mine area and suggestions for preparing catchment treatment plan for mine area.

Extreme Flood for Lakya Dam : The extreme flood for Lakya dam was estimated using Synthetic Unit Hydrograph developed for Lakya Catchment. Data on Physiographic parameters and rainfall from nearest raingauges of India Meteorological Department were used. For reservoir routing, Lakya reservoir expanse with the water body and the tailing deposits was assumed. The extreme flood was routed through the Lakya reservoir with the modified capacities computed based on the tailing deposits upstream in the reservoir. The inflow hydrograph has a peak of 654.69 m^3/sec and a time base of 29 hours. The reservoir routing was carried out with hydrologic routing method, with initial reservoir level to be at 875 m (top of morning glory inlet) and 885 m (crest of overflow inlet of tunnel spillway). Spillway outflow formed input for estimating adequacy of both the spillways in extreme flood situation.

Sediment Yield and Soil Conservation : Soil erosion estimations were carried out with USLE model which is found to be suitable for prediction as it considers various land use practices and management practices prevailing in the study area and also convenient in evaluating the soil conservation measures to control the erosion. The sediment yield estimations were performed in a distributed approach by sub dividing the mine area into 24 land units based on the topography. The erosion rates were moderate except in one land unit.

Based on the results on sediment yield studies and for intense storms of 88.8 mm/hr or higher rainfall, it was found that silt detention structures like PCD I and PCD II may let silt more than permitted into Bhadra river. At present desiltation of PCD I and II is being carried out by KOICL frequently. As the post mining scenario is not clear on the frequency of desiltation it was recommended that monitoring of PCDs for at least three consecutive monsoons after the mine closure was essential for evaluating the soil and water conservation measures. It was also recommended to carry out treatment of catchment draining into PCD I and II, to reduce sediment flow. These included design of drains, terracing, trenching, contour bunding and afforestation.

Hydraulics of tunnel spillway of Lakya Dam

Lakya dam has 3.75m(H) x 4m(W) and 425 m long D-shaped tunnel spillway that discharge water in Kunya holey stream finally joining river Bhadra. There are two inlets viz. Morning Glory inlet at EL. 875 m and Overflow inlet at EL. 885 m. The Morning Glory inlet

▲ *Dips In Weatherd Ore*

is in the form of pipe joining tunnel spillway. The design maximum outflow discharge is 33 m^3/s. The tunnel terminates into a stilling basin. The downstream banks of Kunya stream are protected by providing gabions. A weir has been constructed downstream of stilling basin which controls the tail water levels.

The studies indicated that the maximum design discharge of 33 m^3/s could be passed with an upstream water level at EL 877.31 m and hence the discharging capacity of morning glory spillway was found to be adequate. For avoiding vibrations in morning glory spillway while passing the flood it was suggested to install aeration pipes along the inner face of the piers of the inlet. It was found that, the maximum design discharge could be passed through tunnel with upstream water level at EL 885 m confirming that the discharging capacity of the overflow spillway was adequate.

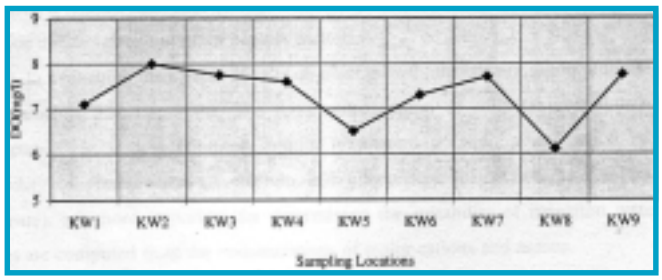
It was recommended that discharge gauging station be established downstream of tunnel spillway outlet to measure actual discharge passing through the spillway and confirm performance of energy dissipater. It was also recommended that an additional spillway was required to be provided to ensure adequate safety in case of malfunctioning of tunnel spillway.

▲ *View of Tailing Deposit from Intake Tunnel Leading to Plant*

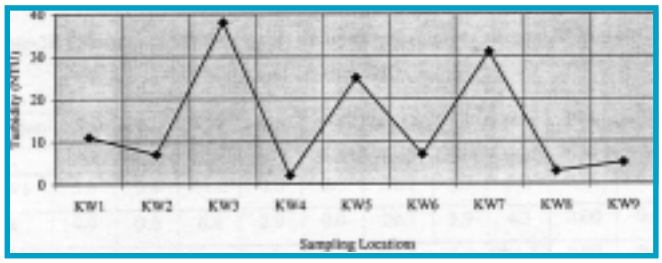
WATER AND TAILING MATERIAL QUALITY STUDIES IN AND AROUND KIOCL AREA, KARNATAKA – PRE AND POST MONSOON INVESTIGATIONS

Indian Council of Forestry Research and Education (ICFRE) approached CWPRS for surface water quality investigations in Kudremukh Iron Ore Company Ltd. (KIOCL) area for preparation of 'Mine Closure Plan'. The locations for carrying out field studies and sample collection were identified on river Bhadra and in other streams which receive washings from mining area. The field studies were conducted during March 2004 and July 2004 respectively during the premonsoon and monsoon seasons. An upstream location was selected for the purpose of comparing the changes in water quality as a result of mining activities in downstream. In-situ determination of unstable water quality parameters like pH, electrical conductivity, temperature, dissolved oxygen and turbidity were carried out at all the selected locations. Samples of water, tailings and riverbed sediments were collected which were analysed in CWPRS laboratory. Analysis for toxic heavy metals also was done.

During the pre-monsoon period field investigations, the surface water was found to be almost neutral or slightly alkaline which was normal and desirable for beneficial uses. The conductivity of the water showed the salt content in water was not high. The possibility of sodium hazard on soil or plants due to use of this water was very low. Possibility of toxicity on living organisms due to presence of heavy metals was also low. The water, as per classification, was under excellent class for irrigation purpose. In all the sites, the water was found well aerated and not containing excessive organic pollutants. The riverbed was found to contain iron in high proportion. Under aerobic situation of water, no major problem of excessive dissolved iron in water was expected. In domestic use, the problem of excessiveiron would be more of aesthetic nature, like stain in laundry and porcelain fixtures. As a sequel, the field studies were also carried out during July 2004. Besides the locations covered in pre-monsoon study, some additional locations for carrying out field studies and two upstream locations were selected for the purpose of comparing the changes occurred in water quality in downstream. The analysis of the samples collected during monsoon season indicated almost the same quality as obtained during non-monsoon season. Low algal growth, and very little primary production, indicated that the water quality of Bhadra river both at upstream and downstream of KIOCL was good and no alarming situation like algal bloom occurred both in pre-monsoon and monsoon seasons. The water quality change caused due to mining at downstream most location is more during monsoon season as compared to pre-monsoon.



▲ *Distribution of DO along Bhadra River*



▲ *Distribution of Turbidity along Bhadra*

Thus, the pre-monsoon and monsoon studies indicated that the quality of the surface water in the KIOCL area was, in general, suitable for beneficial uses including irrigational usages.

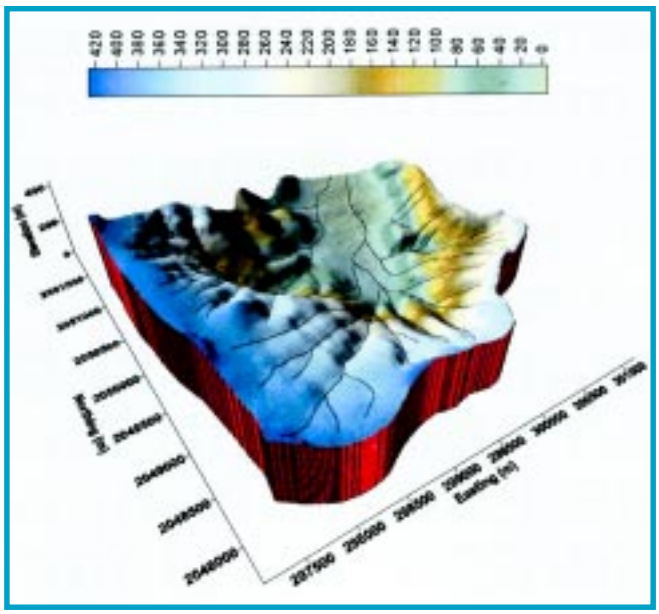
STUDIES FOR MAXIMUM FLOOD ESTIMATION, DETERMINATION OF SAFE GRADE ELEVATION AND STORM WATER DRAINAGE FOR POWER PROJECT OF REL AT NAGOTHANE, MAHARASHTRA

M/s Reliance Energy Limited (REL), Mumbai had proposed to establish a 3000 MW gas based Combined-Cycle Power Project (CCPP) near Nagothane on the left bank of river Amba in Maharashtra state. M/s REL has planned to develop a plot of area 75.0 ha, about 3 km away from Amba river, for its proposed plant. The ground elevation of the plot varies from +7.0 m to +29.0 m above MSL. Amba river basin generally experiences intense rainfall due to South West monsoon. The annual average rainfall of Nagothane is 2766.3 mm. Hydrological studies in respect of this proposed power plant area were taken up by CWPRS through Water and Power Consultancy Services (WAPCOS) India Limited.

Reconnaissance survey of the study area was carried out to study hydrological and hydrometeorological conditions of the project area. Extreme Value analysis of daily and hourly rainfall from nearby stations was carried out to estimate one-day and short duration extreme rainfall depths for different return periods. These rainfall depths were used to estimate maximum flood from plant area, upstream catchment and for flood routing studies.

Available spatial information about the project area was digitized and a Digital Elevation Model (DEM) was developed to extract hydrological and topographical details of the study area. One-dimensional mathematical model for flood routing was used to estimate the high flood levels in channel network in plant area. Using the result of flood routing, safe grade elevation for the plant area was arrived at. The amount of filling material required for filling the plant area upto safe grade elevation was also worked out.

Considering the safe grade elevation suggested, project authorities provided a terracing plan of the plant area in 4 zones with different zonal elevations; which was used to plan a new flow route for the existing channel system. The peak runoff from upstream catchment was computed and routed through the new network with lateral additions from different zones to optimize the diverted channel.



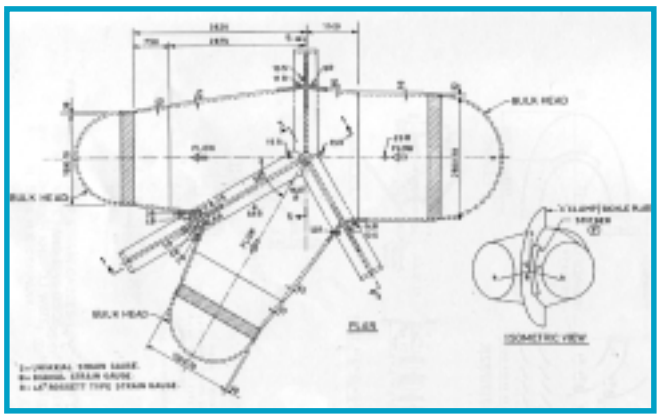
▲ *DEM of Catchment Area of Proposed Dam*

In order to meet water requirements, studies were carried out to find water yield of whole Amba River basin, Amba river upto Pali and for a Proposed dam near plant area. Feasibility studies for construction of an additional KT weir near Nagothane were also carried out. It was found that the proposed KT weir cannot meet the water demand of the project.

STRAIN MEASUREMENTS IN THE PENSTOCK BIFURCATION FOR KHOPOLI POWER HOUSE DURING HYDROSTATIC TEST AT INDIAN HUME PIPE FACTORY, PUNE

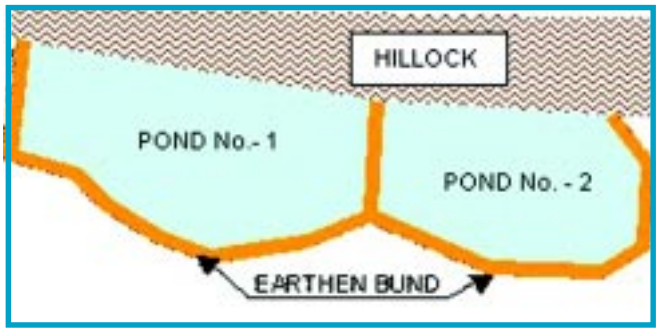
Khopoli Power Generating Station is one of the major power generating units of Tata Hydro-Electric Project feeding electric supply to Mumbai and other western parts of Maharashtra. The present generating station is being renovated by replacing existing penstock system. The new steel lined penstock will feed the up-graded sets of generating units, number 7, 8 and 9 in the new power house. The penstock bifurcates into two parts using "Wye Branch" embedded in anchor block. The Wye branch penstock bifurcation designed by Tata Consulting Engineers, Mumbai was fabricated by Indian Hume Pipe Factory (IHP), Hadapsar, Pune. It has incoming pipe of 2600 mm diameter, which bifurcates into two branches of 1900 mm diameter each. The junction is stiffened by 'C' clamp/sickle plate.

The bifurcation was designed for working pressure of 60 kg/cm^2 and was to be subjected to hydrotest equivalent to 1.5 times the design pressure as per the standard practice, i.e. at 90 kg/cm^2. However, there was a restriction on the upper limit of the hydrostatic pressure upto 90 kg/cm^2 such that the maximum stress level in the Wye piece reached upto permissible limit (80 percent of yield strength of the material) set as per design report submitted by Tata Consulting Engineers. During the hydrotest the test pressure was to be increased gradually from design pressure of 60 kg/cm^2 and at the same time strain on the Wye branch was to be monitored. The prototype strain measurements were undertaken by CWPRS, during the hydrostatic test conducted on the Wye branch at the fabricator's shop, IHP, Pune. The work was undertaken in association with M/s Water and Power Consultancy Services (WAPCOS). Electrical resistance straingauges (20 Nos) were installed from inside and on the outside of the Wye branch for measurement of strain/stress. The maximum stress at the critical location on 'C' clamp of bifurcation for internal pressure of 60 kg/cm^2 and 70 kg/cm^2 was found to be of the order of 5208 kg/cm^2 (510.64 MPa) and 5586 kg/cm^2 (547.70 MPa) respectively. The above stress levels when expressed as percentage of yield strength of the material worked out to 74% and 79.4% for 60 kg/cm^2 and 70 kg/cm^2 respectively which was near the allowable maximum stress value. Since the maximum allowable stress level was reached at 70 kg/cm^2, the bifurcation was not stressed further and hydro test was limited to 70 kg/cm^2. The stress levels at the locations other than the 'C' clamp/sickle plate were within allowable limit. The studies enabled TCE to conduct the hydrotest without exceeding the safe values of stress levels.



STUDIES ON STABILITY OF BUNDS FORMING ASH POND NO.1 & 2 AT MANUGURU, ANDHRA PRADESH

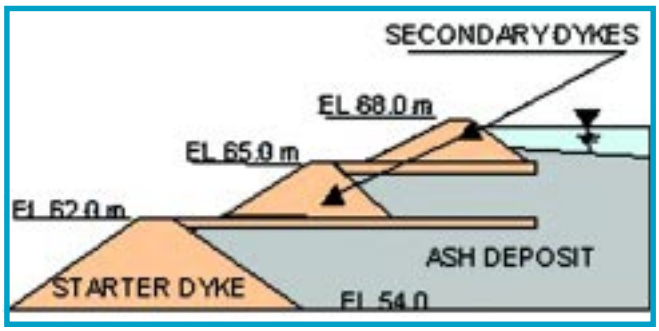
The power required by the heavy water plant at Manuguru, Andhra Pradesh, is supplied by the coal fired captive power plant. The ash produced due to burning of coal is disposed into two ash ponds created by construction of earthen bunds. The height the bund of both the ponds was about 8 m. The bund of pond No. 1 was further raised in two stages of 3 m each by upstream method of construction to increase the capacity.



About 20 m length of the bund of ash pond No.1 breached in January 2004, thereby inundating an area on the downstream by the ash slurry.

To identify the probable cause of failure, field inspection was carried out and drawings of the bund section were studied. It was found that there was no provision of drainage for the water from the ash slurry deposit. The subsequent raising of bund by upstream method of construction created confined zones with impermeable boundaries underneath the base of secondary dykes. When water level in pond No. 1 reached to EL 67 m on the day of mishap, uplift pressure on the base portion of dyke at EL 62 m might have developed due to hydrostatic head of about 5.5 m causing piping and subsequent breach of the bund portion.

It was suggested to lower the maximum water level in the pond to EL 63.5 m to reduce the uplift pressure and to provide loading berm at EL 62 m on downstream



of the bund to counter balance the remaining uplift pressure. A rock fill dyke with thin core and geomembrane was designed for the breached portion. Laboratory testing of soil samples and stability analysis of the bund of pond No. 2 indicated the bund to be safe and sound.

Maintenance and inspection programme for the bunds of both the ponds was chalked out to ensure the safety in future. Assessment of liquefaction potential of ash deposit was recommended to evaluate seismic stability of bunds.

STUDIES FOR INTAKE STRUCTURE AND AREA DRAINAGE FOR NCTPS AND JOINT VENTURE PROJECT, CHENNAI

Tamil Nadu Electricity Board (TNEB) has established two thermal power stations, Ennore Thermal Power Station (ETPS) located at 4.5 km south of the Ennore creek mouth and North Chennai Thermal Power Station (NCTPS), 1.5 km north of the mouth. The ETPS requires 23 m^3/s of water for cooling condensers, which is drawn from the Korattalayar river, a branch of Ennore creek system. The hot water is discharged back to sea through a pipe running on a jetty. Similarly, NCTPS required 27.5 m^3/s of cooling water to be drawn through an intake channel from Ennore creek. Hot water from condensers was let out to sea through a surface discharge system located at about 2 km north of the Ennore creek mouth. Ennore port on the north of the Ennore creek mouth has been developed recently which obstructed the littoral drift movement and the south shoreline advanced by about 150 m within a short period of 6 months. Further, due to drawl of water from Korattalayar river and construction of dams and weirs in the u/s reaches of Ennore creek, the flushing action in the creek was reduced considerably. As a result, in spite of extensive dredging, it was quite difficult to keep the Ennore creek mouth open. This aggravated the situation of shortage of cooling water supply for power stations and the Tamil Nadu state faced severe power supply problem. In view of this situation, studies were conducted at CWPRS to suggest remedial measures to improve the conditions. The studies were carried out on physical thermal model and it was recommended to locate the NCTPS intake in Ennore port basin. As the existing outfall at creek mouth was land locked due to advancement of the shoreline, the outfall discharge was recommended to be re-routed from that point southwards and through the pre-cooling channel developed on the east side of the NCTPS project site. The NCTPS has constructed the pre-cooling channel which limits the temperature rise of hot water to 1^0C over ambient before it meets the creek.

Further, National Thermal Power Corporation (NTPC) in collaboration with TNEB has proposed recently to establish a Joint venture (JV) thermal power project of 1000 MW at Ennore, north of Chennai. The cooling water requirement for the Joint Venture Project would be 50 m^3/s for once through system and 8 m^3/s for closed loop cooling water system. Studies were conducted at CWPRS to verify adequacy of hydraulic design of the intake system proposed for NCTPS in the Ennore port basin and for suggesting modifications, if required, for the following alternatives as below:

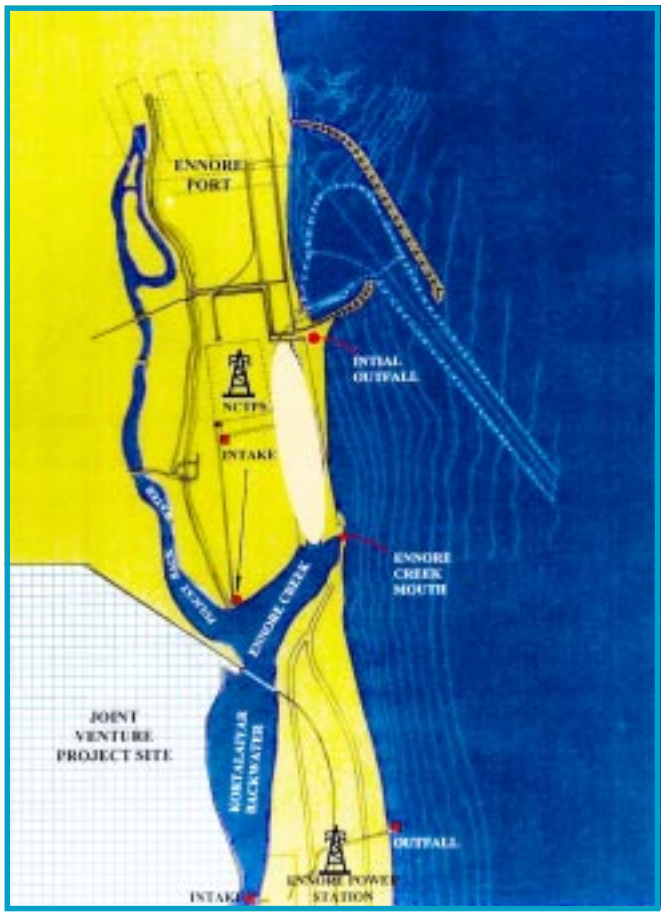
- Drawing cooling water only for NCTPS project
- Drawing cooling water required for NCTPS and ETPS project
- Drawing cooling water required for NCTPS and proposed Joint Venture project of TNEB & NTPC

The intake configuration and levels were suggested keeping in view the water requirement for various alternatives. One-dimensional mathematical model studies confirmed that with 6.0m width of proposed intake channel, 35 m^3/s of water could be drawn comfortably . To draw 50 m^3/s of water for catering to the requirement of JV project or ETPS Project as well, the channel width was suggested to be increased to 8.0m. If the closed loop cooling water system is adopted for the Joint Venture Project, the makeup requirement of about 8 m^3/s could be conveniently met with the withdrawl through the proposed intake of NCTPS.

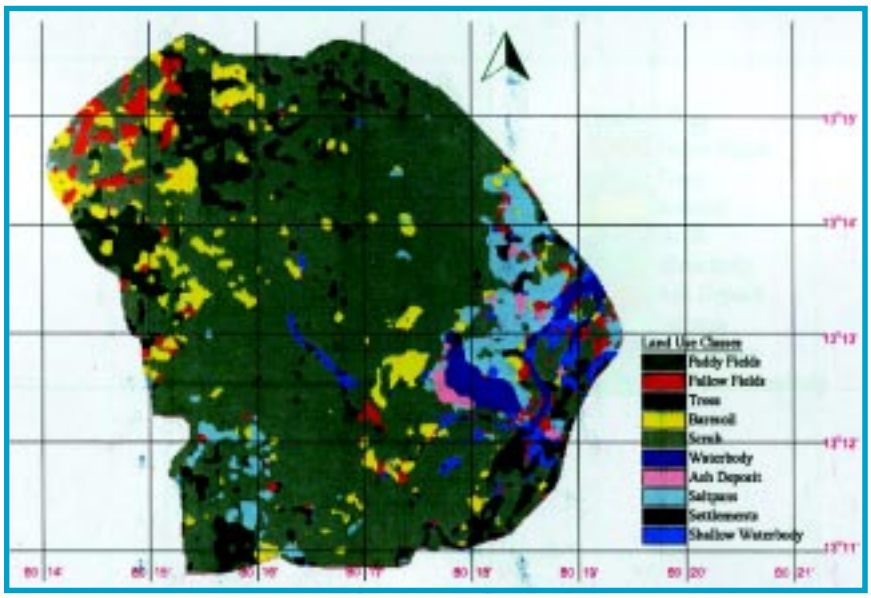
For the Joint Venture Project, the area drainage studies were also conducted at CWPRS. A plot admeasuring an area of 410.76 ha with the ground elevation varying from + 0.0m to + 2.0m above MSL has been earmarked for the proposed JV Project. River Korattalaiyar is a major river which passes very close to the plant boundary. Available spatial information about the

project area was digitized and a Digital Elevation Model was developed. Digital remote sensed data pertaining to the study area was classified and different land cover and land use practices were studied. Available rainfall data were processed and Standard project storm (SPS) for the study area was estimated. The 100 year return period 1 –hourly, 2-hourly, 3-hourly and daily SPS were estimated.

The mathematical model studies were carried out by CWPRS for prediction of high flood levels in Korattalaiyar river to determine safe grade elevation for the plant area. Considering fresh water discharges and the highest of high tide level at the downstream boundary, the peak flood level near plant site was estimated to be +3.07m above MSL and the proposed safe grade elevation level for the Main plant area of 103.19 ha was suggested as +4.07m above MSL. A drainage system with one main channel and 4 tributaries was recommended to drain water from the area. The channel dimensions were optimized using model HEC-RAS.



▲ *Existing Intake and Outfall of ETPS & NCTPS*



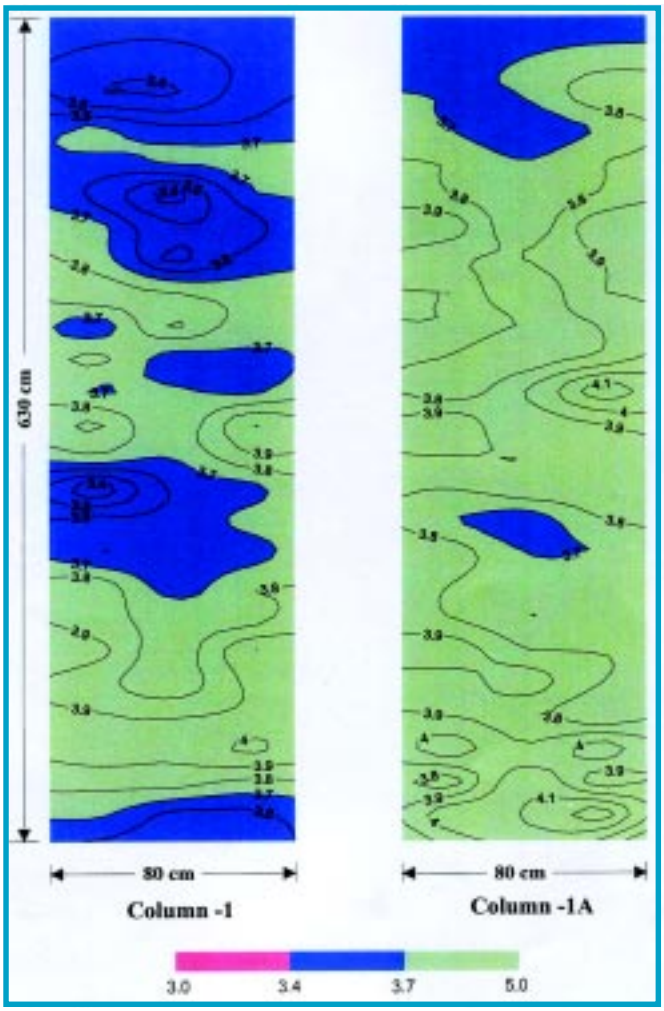
◄ *Image of Korattalaiyar River Basin D/S of V Vallur Anicut*

ULTRASONIC NON-DESTRUCTIVE ASSESSMENT OF QUALITY OF IN-SITU CONCRETE OF 25 MW T.A. FOUNDATION OF UNIT NO.6, ROURKELA STEEL PLANT

The Captive Power Plant No.1 (CPP-I) at Rourkela Steel Plant (RSP), Orissa consists of five steam Turbo-Alternator (TA) units (designated as unit Nos.1 - 4 and 6), which were commissioned about 40 years ago. The RSP authorities decided to replace the turbine of TA Unit No.6 retaining old alternator and supporting frame type R.C.C. foundation for extending its life. It was, therefore, essential to confirm that the concrete of the TA foundation had not suffered from long-term deterioration. Accordingly nondestructive studies were undertaken by CWPRS by employing ultrasonic pulse transmission technique for the exposed portions of the TA foundation with its turbine, alternator and other auxiliary equipment in position. A Portable Ultrasonic Non-destructive Digital Indicating Tester (PUNDIT) with ultrasonic transducers of 37 KHz and 54 KHz frequencies were used for the purpose. Also, statistical analysis of the velocity data was carried out with a view to assess the uniformity of concrete in-situ.

In order to cover the maximum available portions of the TA foundation, vertical and horizontal grid lines (250 mm x 250 mm) were marked on the opposite faces of all the columns and the transverse and longitudinal beams of the deck slab. Travel-times of elastic compressional waves were measured at each grid point formed by the grid lines by using both direct and direct-inclined arrangements of ultrasonic transducers (transmitter and receiver). Knowing the length of travel-path and the corresponding travel-time of waves, velocity of elastic compressional waves was estimated at each grid point. The relative absorption of wave energy was also observed by displaying the transmitted waveforms on an oscilloscope screen.

Based on the values of elastic compressional wave velocities (3.4 km/sec and above) and qualitative assessment of relative absorption of wave energy, the quality of insitu concrete of the TA foundation of Unit No.6 was estimated as good to very good. The velocities less than 3.4 km/sec observed at a few isolated grid points have been attributed to the rough surface conditions of the structural members rather than to poor quality of concrete. Statistical analyses of velocity data had indicated that concrete in the deck slab was equally homogeneous to that in the columns of this TA. foundation.



▲ *Velocity Contours Depicting the Quality of In-Situ Concrete of Columns 1 & 1A*

General Information

BUDGET AND FINANCE

PLAN SCHEMES

The main purpose of the Plan Schemes is to strengthen the infrastructure of the Research Station for serving the Nation more efficiently. Under the Tenth Five Year Plan following three schemes are under implementation.

(Rs in lakhs)

Sl. No.	Name of the Scheme	Actual expenditure 2004-2005
1.	*Upgradation of coastal & offshore data collection capabilities, Remote Sensing & Modernisation of earth science laboratory*	*46.74*
2.	*Upgradation & Modernisation of Research Facilities*	*305.82*
3.	*Improvement of Canal Control through Modern Techniques*	*9.41*
	Total	361.97

During the year 2004-05, the following important activities were undertaken under Plan schemes:

- Field data for Ujjani, Jaikwadi and Bhatghar reservoirs in respect of levels, topopgraphy etc. have been collected
- Imageries for the reservoirs Jaikwadi and Koyna have been identified and acquired
- Reservoir sedimentation studies for Khadakwasla, Jaikwadi and Bhatghar were completed
- Equipment such as Multi-Electrode Resistivity Imaging System, Handheld GPS, Ground Penetrating Radar, etc. were procured
- Two officers were trained in Geographical Information System and Remote Sensing Techniques at NWA, Pune
- Construction of a building for storage and maintenance of field equipment and for National Coastal Data Bank was completed
- Deployment of equipment required for various project and use of related software for analysis / interpretation of field data
- Preliminary drawings and estimates were prepared for hanger for multipurpose wave basin for design of port layouts
- Construction of hangers for studies for spillways and high head structures and wave flumes started
- Procurement of equipment such as Data Acquisition System, 600 KN Universal Testing Machine, Upgradation of mathematical modelling software initiated
- Procurement of essential equipment such as digital Micro-Earthquake Recorder, Petrological Microscope, Resonant Frequency Test equipment, Viscometer, Servers for coastal data and mathematical modelling completed
- Procurement of coastal data for setting up of National Coastal Data Bank
- Conducted 6 training courses on Coastal Erosion and Protection, and "Engineering Geophysics, Seismotectronics, Seismic Design," and "Repairs & Rehabilitation of Distressed Hydraulic

Structures – Diagnosis, Repair Materials and Remedial Measures."

- Training of staff for use of new software packages
- Training of staff for use of Information Technology

NON-PLAN

The Non-Plan annual budget of the Research Station is given below:

(Rs. in crores)

Item/ Head	2004-05			
	BE	RE	FE	Actual
Salary	*16.70*	*16.74*	*17.95*	*17.94*
Non-Salary	*3.21*	*3.09*	*3.09*	*2.94*
Total (Gross)	*19.91*	*19.83*	*21.04*	*20.88*
Recovery	*6.00*	*6.00*	*6.50*	*7.14*
Net	13.91	13.83	14.54	13.74

WELFARE OF STAFF AND WEAKER SECTIONS

Redressal of Staff Grievances

A grievance cell has been constituted under the chairmanship of Dr A. K. Basu, Joint Director to look into the grievances of staff members and for their redressal.The data relating to Grievance Cell, during the year are tabulated below:

- Number of grievance cases pending as on 31.03.2005 - Nil
- Number of grievance cases received - Nil
- Number of grievance cases disposed off - Nil
- Number of grievance cases pending as on 31.03.2005 - Nil

Minority Welfare

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

Monitoring of Reservation for Physically Hndicapped

Monitoring of the recruitment of physically handicapped persons is being done to ensure fulfillment of three percent quota.

Monitoring of Reservation (for SC/ST/OBC)

Monitoring of the recruitment of candidates from SC / ST / OBC category is made following the guidelines issued from time to time. Dr A. K. Basu, Joint Director guides the overall matters in this regard as Liaison Officer. A summary of posts filled from SC / ST / OBC / PH categories is furnished below :

Group	Position as on 31.3.2005				
	SC	ST	OBC	PH	UR
A	** 24*	*02*	*02*	** 01*	*129*
B	*31*	*16*	*14*	*02*	*154*
C	*60*	*31*	*24*	*13*	*350*
D	*85*	*25*	*10*	*13*	*225*
* One SC Officer is PH.					

Committee for the Preservation and Enforcement of Right to Gender Equality of Working Women

There are five members on the committee and the composition of the committee is as per the guidelines from the Honourable Supreme Court of India. Meetings of the committee are held regularly and no case was referred to the committee during the year.

VIGILANCE AND DISCIPLINARY CASES

The vigilance/disciplinary cases and complaints concerning officers and staff of Central Water and Power Research Station received proper and prompt attention. The break-up of the vigilance and disciplinary cases in respect of different categories of officers and staff are given in the tables below :

Vigilance Cases

Sr. No.	Particulars	Categories of officers/staff			
		Group 'A'	Group 'B'	Group 'C'	Group 'D'
01	Number of cases pending in the beginning of the year	Nil	Nil	Nil	Nil
02	Number of cases added during the year	Nil	Nil	Nil	Nil
03	Number of cases disposed off during the year	Nil	Nil	Nil	Nil
04	Number of cases pending at the end of the year	Nil	Nil	Nil	Nil

Disciplinary Cases

Sr. No.	Particulars	Categories of officers/staff			
		Group 'A'	Group 'B'	Group 'C'	Group 'D'
01	Number of cases pending in the beginning of the year	Nil	—	01	01
02	Number of cases added during the year	Nil	01	02	01
03	Number of cases disposed off during the year	N.A.	—	02	01
04	Number of cases pending at the end of the year	Nil	01	01	01

PAPERS PUBLISHED

No.	Authors	Title	Reference
1.	Balakrishna S. Vaidya A.M. Sharma V.B. Barve K.H. Kanetkar C.N.	Mathematical modeling for design of port layout	Seminar on "Maritime Issues", Mumbai, April 2004
2.	Khare P.K. Ramesh U.	Application of mathematical model in identification of dumping ground	
3.	Goel P.K. Wadwankar S.V.	Measurement and control of water contamination in servo hydraulic systems	Seminar on "Hydraulic system contamination Fluid power exhibition & seminar-FPES 04", Bangalore, May, 2004
4.	Kshirsagar M.M. Vijayagopal P. Kannan S. Bapat A.D.	Flood warning system for a thermal power project in flood plain area	Indian Journal of Power and River Valley Development, May-June 2004
5.	Poonawala I.Z. Purohit A.A.	Hydraulic modeling of breakwaters in port development	All India seminar on "Ports of India – Future Developments and Challenges", Mumbai, September 2004
6.	Purandare U.V. Prabhat Chandra	Harnessing port development potential in large bays –Case study of bay at Ratnagiri	
7.	Vaidya Shanti Swain K.K. Kamble K.J. Basu A.K.	Trophic state of Panshet and Ujjani reservoirs in relation to phosphorus concentration and other factors	International conference on "Hydraulic Engineering: Research and Practice (ICON-HERP-2004)", Roorkee, October 2004
8.	Deshmukh D.N. Ali S.N. Shitole M.S.	Mathematical model studies for simulation of flow in Tapi river	
9.	Deshmukh D.N. Roman U.C. Ali S.N.	Mathematical model studies for proposed bridge on Kosi river	
10.	Poonawala I.Z. Kudale M.D. Purohit A.A.	Restoration of distressed breakwaters in India – Case studies	International seminar on "Coastal area construction management", Mumbai Oct.04
11.	Purohit A.A. Kulkarni S.P. A.V. S.R.S. Ravi Sankar N.	Performance of detached offshore seawall for coastal protection at Udwada, Gujarat	

No.	Authors	Title	Reference
12.	Bhosekar V.V. Sridevi M.I. Deolalikar P.B.	Hydraulic model studies for spillway with 21 m depth of overflow –Case study	National Conference on "Hydraulics and Water Resources – HYDRO 2004", VNIT, Nagpur, December 2004,
13.	Deshmukh D.N. Roman U.C. Naved Ali S. Kulkarni S.D.	Mathematical model studies for proposed bridge on Kosi river	
14.	Shitole M.S . Singh M.N.	Case studies of bridges, alluvial, clayey and boulder streams with regard to river morphology, scour and protection work	
15.	Pawar M.K. Oak R.A. Shitole M.S.	Degradation of river due to mining operations and its effects in the vicinity- Case study	
16.	Shrivastava Y.N. Patil S.L. Marandi D.C. Deolalikar P.B.	Effect of spillway operation on the vortex formation at power intake of run-of river scheme	
17.	Srivastava Y.N. Patil S.L. Deolalikar P.B. Marandi D.C. Chavan V.S.	Experience in operation of a intake with submergence below minimum draw down level	
18.	Singh M.N. Shitole M.S. Kerimani S.S.	Hydraulic model studies for bridge design - Case studies	
19.	Shitole M.S. Shah C.M. Verma M.K. Khare S.M.	Hydraulic model studies for sediment exclusion arrangement at power intake, Kol dam hydroelectric project - Case study	
20.	Prabhat Chandra Chavan S.S Purandare U.V.	Hydraulic studies for development of barge channel in Zuari estuary, Goa	
21.	Kapileshwar P.S. Patil U.B. Purandare U.V.	Hydrodynamic studies for the development of fisheries centre at Varsoli, Alibag	
22.	Ramesh N. Berde P.V. Chaudhary Babu Purandare U.V.	Morphological behaviour of large range tide - Case study	

No.	Authors	Title	Reference
23.	Atakekar A.K. Gangal A.C.	Potential of embedded systems for hydraulic instrumentation	National Conference on "Hydraulics and Water Resources – HYDRO 2004", VNIT, Nagpur, December 2004,
24.	Kudale M.D. Purohit A.A. Ravi Sankar N. Sarma A.V. S.	Prediction of extreme storm surge level for safe guard coastal - Case study	
25.	Hradaya Prakash	Relationship between suspended and total sediment lead in alluvial stream	
26.	Bhambure S.R. Abdul R. P.M. Chavan A.R.	Selection of pumps for field applications	
27.	Goel P.K. Bhonde K.G. Chavan Y.M.	Suspended sediment samplers characteristics and future research needs	
28.	Kashid M.B. Tripathi V.K. Chavan A.R. Ghule S.J.	Turbines for small hydro	
29.	Kulkarni S. Murugeshwari R. Balakrishna S. Kanetkar C.N.	Wave model studies for design of port layout at Pawas bay	
30.	Kudale M.D. Kanetkar C.N. Poonawala I.Z.	Design wave prediction along the coasts of India	Third Indian National Conference on "Harbour and Ocean Engineering INCHOE 2004", Goa, December 2004
31.	Poonawala I.Z. Kudale M.D. Purohit A.A. Kulkarni S.P.	Rehabilitation of rubblemound breakwaters by providing a wide toe-berm	
32.	Patil B.M. Kothandaraman A.L. Kanetkar C.N. Ranganath L.R. Manivanan R.	Simulation of warm water dispersion in coastal environment	
33.	Purandare U.V. Nagendra T. Ramesh N. Kulkarni S.H.	Dredging strategies for the sustenance of navigation channels in large tidal range regions, Kandla port –Case study	

No.	Authors	Title	Reference
34.	Purandare U.V. Prabhat Chandra	Potential of drowned river valley estuaries on Indian west coast for development and harnessing	Third Indian National Conference on "Harbour and Ocean Engineering INCHOE 2004", Goa, December 2004
35.	Joshi V.B. Phani Kumar M. Purandare U.V.	Assessment of wave transmission coefficient through low core permeable breakwater – proto model comparison	
36.	Dhawan K.R. Govindan S.	Study of in-situ stresses in the rock mass at surge shaft of Koyna hydroelectric project, Stage-IV, Maharashtra	Seminar on "Tunneling Asia-2004", New Delhi, December 2004
37.	Balakrishna S. Sharma V.B. Singh A.K. Ghosh L.K.	Damming of tidal channel to create fresh water lake	Seminar on "Development vis-à-vis Environment Protection", Port Blair, December 2004
38.	Atkekar N.D. Joshi M. A. Kokate V. K.	Change detection using image processing	International conference on "Multi-Displinary Aspects of Engineering – IMAE 05", January 2005
39.	Sinha J. Gopalakrishna B. Kanerkar C.N. Ghosh L.K.	Salinity variation in Chilika lake due to fresh water inflow	"Asian Wetland Symposium 2005", Bhubaneswar, February 2005
40.	Desai V.T. Sathe A.K. Pillai S.J.	Strengthening of the scroll cases / spiral casings and draft tubes of hydropower project - Case studies	National Conference on "Recent Trends in Geotechnology", Pune, February 2005
41.	Tongaonkar P.B. Shirke J.M. Muralidhar B. Chhatre M.V.	Sub-soil investigation to resolve problems encountered in foundation wells during construction of road bridge across river Tapi near Idgaon, Maharashtra	
42.	Surwade K.B. Ramesh C. Kshirsagar M.M. Govindan S.	Assessment of peak maximum rainfall for estimation of peak flood for ungauged Lakya catchment - Case study	Publication "Hydrology Journal", March 2005

PARTICIPATION IN SEMINARS / SYMPOSIUM / CONFERENCES / WORKSHOPS

No.	Name	Seminar / Symposia / Conferences / Workshops
1.	Shirke J.M. Vaidya M.M.	Seminar on "Recent Trends in Geotechnical Engineering", Maharashtra Institute of Technology, Pune, April 2004
2.	Kanetkar C.N. Ramesh U. Balakrishna S.	Seminar on "Maritime Issues", Mumbai, April 2004
3.	Desai V.T.	Conference on "Large Dams and Hydro Power Development", New Delhi, May 26-28, 2004
4.	Vaidya S.P. Swain K.K. Gupta K.K. Dhilipkumar R.	Workshop on "Mine Restoration", Pune, June 2004
5.	Khaparde N.P.	Training Programme on "Advances in Hydraulic Flow Measurement", Pantnagar, Uttaranchal, June 2004
6.	Surwade S.B.	Refresher Course for "In-service ISS officers on Visual FoxPro", New Delhi, June 2004
7.	Prabhakar V.M. Pangavhane S.M. Savitri Hansda Basu A.K.	Wetland Restoration and Delineation, Pune, June 2004
8.	Deolalikar P.B.	"Hydro Power Professionals Meet", New Delhi, July 2004
9.	Ali Syed Naveed Bagwan Anilkumar Shanware P. D. Gupta I.D. Sridevi M.I.	Workshop on "Fuzzy Logic and its application in Engineering", Pune, July 2004
10.	Bendre V.M.	Conference of Chief Secretaries, Principal Secretaries (Irrigation and Water Resources) and Command area authorities of States and Union territories, Vigyan Bhawan, New Delhi, August 2004
11.	Bhosekar V.V. Paithankar M.T. Kubal S.K. Gupta K.K. Hradaya Prakash Narayan Prasad Sonawane H.G. Barve K.H.	"Second All India Jal Sahitya Sammelan", Pune, August 2004
12.	Purohit A.A. Purandare U.V. Ramesh U.	All India Seminar on "Ports of India-Future Developments and Challenges", Mumbai, September 2004

No.	Name	Seminar / Symposia / Conferences / Workshops
13.	Biradar K.C.	All India Seminar on "Switch Gear-Recent Development and Technology Management", Indian Institute of Technology, Mumbai, September 2004
14.	Mathew F.T.	Refresher Course on "Market Research", New Delhi, September 2004
15.	Ghosh A.K.	Training Programme on "Rock Engineering for River Valley Project", New Delhi, September-October 2004
16.	Jatwa S. Katte K. V.	Training Programme on "Applications of Remote Sensing & GIS in Water Resourse Sector", NWA, Pune, October 2004
17.	Shende V.J. Hanumanthappa M.S.	Course on "Earthquake Resistant Design of Building, Institution of Engineers (India), Pune, October 2004
18.	Shitole M.S. Vaidya S.P.	International Conference on "Hydraulic Engineering, Research & Practice, (ICON-HERP-2004)", Indian Institute of Technology, Roorkee, October 2004
19.	Ganguly S. Atkekar N.D.	Training Course on "Micro Controller based Product Design", Centre for Electronics Test Engineering, Pune, October 2004
20.	Venugopal K.	National Seminar on "Augmenting Ground water Resources by Artificial Recharge (AGWAR Project)", Pune, October 2004
21.	Kudale M.D. Purohit A.A. Sarma A.V.S.	International Seminar on "Coastal Area Construction Management", Mumbai, November 2004
22.	Pokale U.B. Gaikwad D.T. Joshi B.Y.	Seventh National Convention on "Library & Information Networking", Pune, November 2004
23.	Abdul Rahiman P.M.	National Conference on "Fluid Mechanics and Fluid Power", Kolkata, December 2004
24.	Mehendale P.B. Ramesh N. Hradaya Prakash Nemani Ravi Sankar Tripathi V.K. Shitole M.S. Srivastava Y.N. Bhosekar V.V. Srivastava Y.N.	National Conference on "Hydraulics and Water Resources - HYDRO 2004", Visweswaraya National Institute of Technology, Nagpur, December 2004
25.	Purandare U.V. Kudale M.D. Patil B.M. Nagendra T Jagadeesh H.B.	National Conference on "Harbour and Ocean Engineering (INCHOE) 2004", December 7-9, 2004, Goa

No.	Name	Seminar / Symposia / Conferences / Workshops
26.	Deogade R.B. Khandagale H.R.	Training Programme on "Surface Water Data Entry Software", NWA, Pune, December 2004
27.	Narayankar K.N. Sonawane A.D.	Training Course on "Networking / Internet Working Technologies and Wireless Technologies", Pune, December 2004
28.	Vijayagopal P.	Training Programme on "Application of Remote Sensing & Geographical Information System in Water Sector", NWA, Pune, January-February 2005
29.	Subba Rao Ch. Hanumanthappa M.S.	Training Programme on "Geotechnical Investigation & foundation Treatment for River Valley Projects", New Delhi, January 2005
30.	Sinha J.	Asian Wetland Symposium 2005, Bhubaneswar, February 2005,
31.	Azamathullah H. Md.	Fifth International R&D Conference, Bangalore, February 15-18, 2005
32.	Harshe S.A.	National Conference on "Occupational Health, Safety & Environment", Pune, February 2005
33.	Desai V.T. Pillai S.J.` Tongaonkar P.B.	National Conference on "Recent Trends in Geotechnology", Pune, February 2005
34.	Kulkarni B.S.	Training Programme on "General requirements for the competence of Testing and Calibration Laboratories & Internal Audit as per ISO/IEC 17025 (D-508)", Mumbai, February 2005
35.	Kudale M.D. Patil B.M.	Seminar on 'Tsunami and Coastal Protection', CESS, Thiruvananthapuram, February 11, 2005
36.	Bhore M.P.	Training Programme on "Geotechnical Instrumentation for River Valley Projects", New Delhi, February-March 2005
37.	Desai V.T. Pillai S.J. Sathe A.K.	National Seminar Cum Business Meet on "Use of Fly Ash in Hydro Sector (Fly Ash India 2005)", Mumbai, March 2005

CONFERENCES / COURSES / MEETINGS ORGANISED BY CWPRS

ADVANCED COURSE ON ENGINEERING GEOPHYSICS SEISMO-TECTONICS AND SEISMIC DESIGN

Advanced course on Engineering Geophysics, Seismotectonics and seismic design was organized at CWPRS for officers of Geological Survey of India (GSI) from 6th to 13th December 2004. In all 15 officers of GSI, from different regions participated in the course. CWPRS officers functioned as Faculty for course.

The topics covered in engineering geophysics included seismic refraction and reflection, gravity, magnetics, electrical resisitivity, up-hole, down-hole and cross-hole techniques, tomography, ground penetrating radar, borehole logging and tracer techniques. Topics covered under seismotectonics and seismic design included deterministic and probabilistic approach for seismic hazard analysis and seismic zoning. Demonstration of geophysical equipment was also arranged. GSI officers actively participated in the discussion. Both the faculty of CWPRS and the participants of GSI learned from each other's experience. On the last day, as part of the course, group discussion was arranged when senior officers of GSI participated.

TRAINING COURSES ON COASTAL EROSION AND PROTECTION FOR THE ENGINEERS OF MAHARASHTRA AND KARNATAKA STATES

Maritime States have to construct coastal engineering works such as seawalls and anti-sea erosion bunds for protection of beaches, which involves a large expenditure. It is essential that trained personnel having adequate knowledge of coastal engineering are associated with the Coastal Engineering works in each state. In addition to the knowledge of design of coastal structures, they should also be aware of the coastal processes, effect of obstructing the littoral drift and various remedial measures. In view of this, under the tenth plan scheme National Coastal Data Bank, training courses are conducted for different maritime status. During the year two such courses were conducted for the engineers from states of Maharashtra, Karnataka and Union Territory of Pondicherry.

Training course for the engineers from Govt. of Maharashtra was organized during 26th to 30th July 2004. Twenty engineers belonging to the Harbour Divisions from Thane, Mumbai, Raigad, Ratnagiri and Sindhudurg districts participated in the course.

Training Course for the engineers from Govt. of Karnataka was conducted from 8th - 11th Sept. 2004. Total twenty-eight participants from Govt. of Karnataka along with two participants from Union Territory of Pondicherry attended the training course. The participants from Govt. of Karnataka belonged to Inland Water Transport (IWT), Karnataka Engineering

Research Station (KERS) and National Highway Division.

Lectures on various topics of coastal engineering such as overview of Coastal Engineering, wave mechanics, tidal hydrodynamics, coastal processes, design wave prediction, design of coastal structures, field data collection, innovative methods in coastal protection etc. were delivered by the various CWPRS officers. Information about the field data collection, analysis and its utility for the design of shore protection works was also covered in the course.

It was emphasized that for coastal erosion sites, data in respect of beach profiles should always be collected immediately after the monsoon season; so that the worst condition of the eroding beach will be simulated in the model which will help in the design of a stable coastal structure. A demonstration of the various field equipment was also given to the participants. Use of Regular and Random wave flume facilities for design of coastal protection structure was also explained. The lecture on Innovative Methods for construction of Seawall, Groynes using Gabions, Detached Seawalls using Chains of Concrete Blocks etc. was also delivered.

The participants though engaged on construction of these structures, lacked the scientific background about the coastal phenomena. However, after attending the training course, the basic concept of waves, tides, necessity of coastal protection, different methods of coastal protection etc were clear to them. In order to demonstrate the use of innovative techniques in coastal protection a field trip to nearby site at Versoli and Mandwa in Alibag Taluka was arranged at the end of the courses.

SHORT COURSE ON REHABILITATION OF DISTRESSED HYDRAULIC STRUCTURES- DIAGNOSIS, REPAIR MATERIALS AND REMEDIAL MEASURES

Hydraulic structures like dams, aqueducts, bridges, powerhouse complexes built at very high cost and expected to last for many years, may get damaged because of number of reasons affecting their durability and watertightness.

Therefore repairs and rehabilitation of such structures of national importance is necessary to enhance their life. CWPRS is actively associated with repairs, strengthening / restoration of such damaged structures by making use of epoxy compounds for more than 30 years. With a view to share experience and to bring about awareness among the engineers/personnel engaged in repairs and maintenance, consulting engineers, contractors etc. the two day course was organized at CWPRS on 10th June and 11th June 2004. CWPRS Officers and experts from the manufacturers of epoxy and construction chemicals were the faculty members for the course. A total of 52 participants from Government departments such as Koyna Project, Sardar Sarovar Project, Gujarat, Central Design Organization (CDO), Nasik, Central Soil & Material Research Station (CSMRS), New Delhi, Nuclear Power Corporation of India Ltd. (NPCIL), Mumbai and Bombay Municipal Corporation, private epoxy manufacturer's / applicators like M/s Beck India Ltd., Krishna Conchem Pvt. Ltd., Forsroc Chemcials, Akshat Enterprises, Infinity Construction attended the course.

The course was inaugurated by Shri Y N Apparao, Chairman-cum-Managing Director, Sutlej Jal Vidyut Nigam Ltd., New Delhi. On the backdrop of the course, the manufacturers of epoxy compounds displayed their products. Similarly, firms dealing with equipments for marine application, demonstrated their equipment. The participants were also taken around a few models and laboratories in CWPRS.

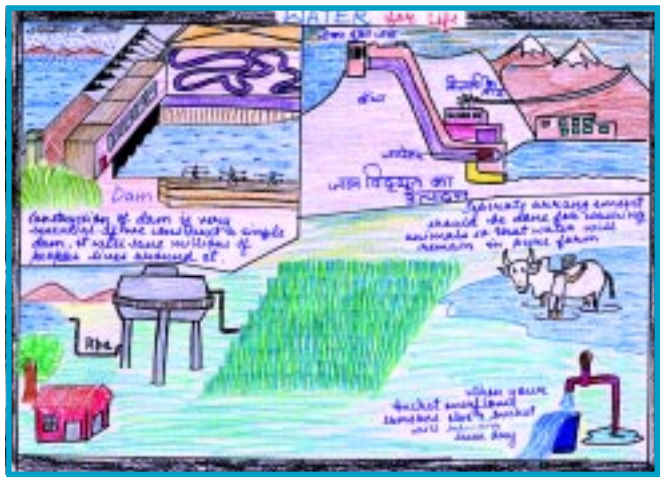
In all, there were eight lectures; six lectures were given by the officers from CWPRS and two invited lecturers from industry. The topics covered by the lecturers were role of nuclear logging in rehabilitation of dams, rehabilitation of distressed hydraulic structures with epoxy application, rehabilitation of hydropower plants - case studies, epoxy system for rehabilitation of hydraulic structure over and underwater, alkali aggregate reaction in concrete preventive measures and rehabilitation, distress in hydraulic structures and remedial measures, tracer technique for dam seepage investigation and advances in material and techniques in repairs to concrete structures.

CELEBRATIONS OF WORLD WATER DAY

The World Water Day was celebrated at Pune in CWPRS on 22nd March, 2005 jointly by various organizations under the Ministry which include Central Water & Power Research Station, National Water Academy and Pune offices of Central Water Commission, Central Ground Water Board and National Water Development Agency. More than 500 participants attended the function. This included representatives from Water and Power Consultancy Service, Indian Society for Hydraulics, Indian Water Resources Society, Teachers and children from nearby

schools and media personnel in addition to the staff from organizing institutes. As a part of celebration, following programmes were organized

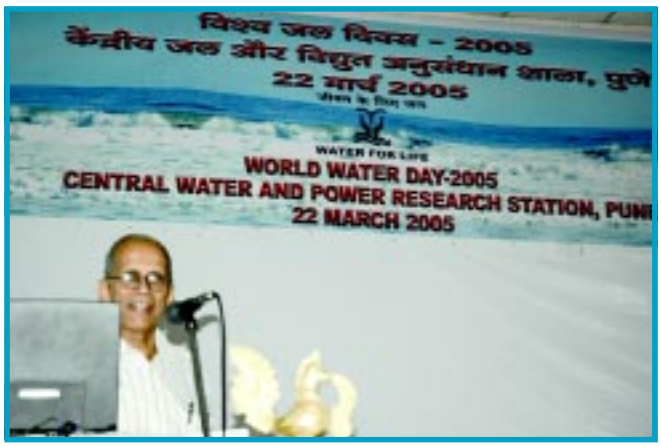
A drawing competition on water related subjects was organized in nearby schools and also for CWPRS Colony children on 19th & 20th March, 2005. Total 150 children participated in the competition. Two winners from each school and CWPRS Colony were selected. In spite of examination time, there was overwhelming response from schools and children.



A Kavi Sammelan on the theme “Water For Life” was organized on 21st March, 2005 at CWPRS Auditorium. In all 13 poets presented their views / ideas on use and conservation of water in their self-written poems.

One-day seminar was organized on 22nd March, 2005 at CWPRS in two sessions. The morning session was held in Multi-Purpose Hall at CWPRS colony campus.

Mrs. V.M. Bendre, Director, CWPRS welcomed the chief guest, Dr. C.D. Thatte, media persons from different newspapers, Press Information Bureau and other dignitaries. A Prize distribution ceremony followed the welcome address. Chief guest and Director, CWPRS gave prizes and certificates to the winners of drawing competition and participants of poetry recitation. The selected poems were presented by the poets, which included different messages related to water conservation, power of water etc.

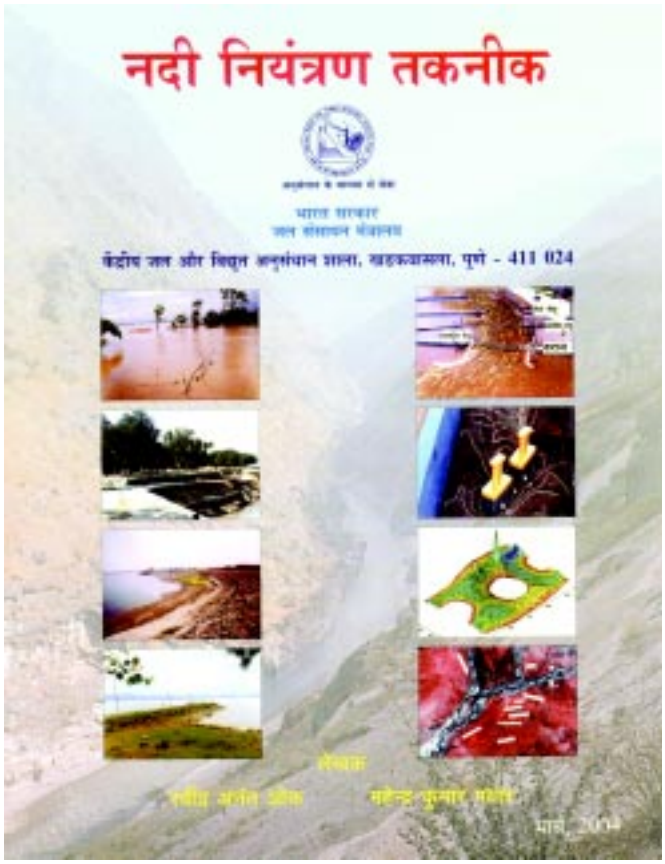


Dr. Thatte, Formar Secretary, Ministry of Water Resources delivered a theme address on "Water For Life". Shri K.R. Joshi, Chief Engineer, NWA, proposed a vote of thanks and concluded the morning session.

The technical session with seven presentations on water related subject was organized in the afternoon. About 150 persons participated in the afternoon session. Wide publicity was given by the local news papers in Prabhat, Sakal, Lokmat, Samna and Maharashtra Times. Aaj Ka Anand and Times of India.

Ministry of Water Resources celebrated World Water Day by organizing appropriate functions throughout the country.

In the Ministry itself the technical memorandum on " **unh fu;=.k rduhd** " was released at the auspicious hands of the Honorable Minister of Water Resources Shri Priyaranjan Dasmunsi. Smt. Sheila Dixit, Honorable Chief Minister, Delhi, graced the occasion. This technical memorandum was authored by CWPRS.



LECTURES DELIVERED BY CWPRS OFFICERS

No.	Name	Topic	Course Details
1.	Chavan A. R.	Cost optimization through use of pumps as turbines in mini & micro hydel projects	Induction Training for "Newly Recruited Civil Engineers of NTPC", NWA, Pune, April 2004
2.	Kashid M.B.	Selection of hydro mechanical equipment for mini & micro hydel projects	
3.	Sinnarkar R.M.	Selection and design of gates and valves for mini & micro hydel projects	
4.	Rani C.K.	Role of nuclear logging in rehabilitation of dam	"Repairs and Rehabilitation of Distressed Hydraulic Structures - Diagnosis, Repair Materials and Remedial Measures", CWPRS, Pune, June 2004
5.	Sathe A.K.	Various aspects of rehabilitationof distressed hydraulic structures with case studies of epoxy application	
6.	Desai V.T.	Epoxy resins for rehabilitation of hydro power plants - case studies	
7.	Shirke J.M.	Alkali aggregate reaction in concrete, preventive measures and rehabilitation	
8.	Ali Rizwan	Distress in hydraulic structures and remedial measures	
9.	Kamble R.K.	Tracer techniques for dam seepage investigation	
10.	Ramkrishna T.V.S.	Myths and facts about reservoir induced seismicity- recent developments	Training Course on "Coastal Erosion & Protection Works for Engineers of Maharashtra", CWPRS, Pune, July2004
11.	Ghosh L.K.	Overview of coastal engineering	Training Programme on "Environmental Manage-ment of Water Resources Development Projects", NWA, Pune, July 2004
12.	Joshi V.B.	Coastal engineering aspects of waves	
13.	Nagendra T.	Basic concepts of tidal hydrodynamics	
14.	Kanetkar C.N. Patil B.M.	Coastal processes	
15.	Purohit A.A.	Design wave prediction	
16.	Kudale M.D.	Coastal erosion and protection	
17.	Poonawala I.Z.	Design of coastal structures	
18.	Purandare U.V.	Coastal erosion and mitigation - case studies	
19.	Prabhat Chandra	Coastal inlets on west coast	

No.	Name	Topic	Course Details
20.	Khare P.K.	Field data collection, analysis and instruments	Training Course on "Coastal Erosion and Protection Works for Engineers of Maharashtra", CWPRS, Pune, July 2004
21.	Oak R.A.	River training works	
22.	Tongaonkar P.B.	Soil mechanics applied to coastal engineering	
23.	Ramesh U.	Hydraulic modelling techniques in coastal engineering	
24.	Kulkarni S.P.	Data requirements for shore protection works	
25.	Purohit A.A.	Innovative methods in coastal protection	
26.	Oak R.A.	Scour phenomena	Senior Professional Course (Bridges & General) for SG & JA Grade Officers, IRICEN, Pune, August 2004
27.	Chavan A.R.	Flow characteristics study, model studies for cavitation, aeration of flow	Analysis and Design of Hydroelectric Projects, NWA, Pune, August 2004
28.	Singh C.B.	Hydrodynamic flow studies using FEM	
29.	Bendre V.M.	Dam instrumentation	Dam Instrumentation,COEP, Pune, August 2004
30.	Ghosh L.K.	Overview of coastal engineering	Training Course on "Coastal Erosion and Protection Works for Engineers of Karnataka and Pondicherry", CWPRS, Pune, September 2004
31.	Jagadish H.B.	Coastal engineering aspects of waves	
32.	Nagendra T.	Basic concepts of tidal hydrodynamics	
33.	Kanetkar C.N. Patil B.M.	Coastal processes	
34.	Purohit A.A.	Design wave prediction	
35.	Kudale M.D.	Coastal erosion and protection	
36.	Poonawala I.Z.	Design of coastal structures	
37.	Purandare U.V.	Coastal erosion and mitigation - Case studies	
38.	Prabhat Chandra	Coastal inlets on west coast	
39.	Khare P.K.	Field data collection, analysis and instruments	
40.	Oak R.A.	River training works	

No.	Name	Topic	Course Details
41.	Tongaonkar P.B.	Soil mechanics applied to coastal engineering	Coastal Erosion and Protection Works for Engineers of Karnataka and Pondicherry, September 2004
42.	Ramesh U.	Hydraulic modelling techniques in coastal engineering	
43.	Kulkarni S.P.	Data requirements for shore protection works	
44.	Purohit A.A.	Innovative methods in coastal protection	
45.	Shende V.J.	Myths & facts about reservoir induced seismicity - recent developments	
46.	Deolalikar P.B.	Physical, mathematical & desk studies for hydropower development	II nd Induction Training Programme for Directly Recruited Engineers of NTPC, NWA, Pune, October 2004
47.	Deshpande N.V.	Seismological studies of river valley projects - Part I	
48.	Ramkrishna T.V.S.	Seismological studies of river valley projects - Part II	
49.	Patil S.L.	Overview of model studies for hydraulic design of powerhouse and tailrace channel	
50.	Shirke J.M.	Geotechnical investigations for hydro power projects at various stages of projects	
51.	Rajkumar	Hydraulic model studies model for Tala and Chamera stoplog gates	
52.	Shah C.M.	Technique of sediment control with special reference to hydropower projects	II nd Induction Training Programme for Directly Recruited Engineers of NTPC, NWA, Pune, October 2004
53.	Ghosh N.	Geophysical investigation for hydroelectric projects - An overview	
54.	Oak R.A.	River morphological studies applying RS-GIS techniques	II nd Induction Training Programme for Directly Recruited Engineers of NTPC, NWA, Pune, November 2004
55.	Oak R.A.	Case study - river morphological behaviour of Brahmaputra	
56.	Wadhwa R.S.	Geophysical investigations for hydroelectric project - Case studies	
57.	Gupta I.D.	Dynamic analysis of concrete dam	

No.	Name	Topic	Course Details
58.	Gupta I.D.	Estimation of site specific seismic parameters for earthquake resistance design of structures	II[nd] Induction Training Programme for Directly Recruited Engineers of NTPC, NWA, Pune, November 2004
59.	Deolalikar P.B.	Importance of physical model studies for hydropower development in India	
60.	Sinnarkar R.M.	An overview of model studies in hydraulic designs of stoplog and vertical lift gates	II [nd] Induction Training Programme for Directly Recruited Engineers of NTPC, NWA, Pune, December 2004
61.	Bhosekar V.V.	Latest trends in hydraulic designs of spillway and energy dissipaters	
62.	Sridevi M.I.	Hydraulic designs of breast wall / divide spillways for flushing of reservoirs	
63.	Patil R.G.	Hydraulic model studies and designs of surge tanks including water hammer analysis	
64.	Bhajantri M.R.	Hydraulic model studies for Tala and Chamera dam spillway	
65.	Kashid M.B.	Turbine runner -design for silty water and selection guidelines	
66.	Kulkarni B.S.	Flow meters, flow through closed conduit with special reference to hydropower plants	
67.	Shah C.M.	Model studies and design of desilting basin	
68.	Kulkarni B.S.	Overview of hydraulics of flow through pipes	
69.	Rao M.M.	Water and power information system, CWPRS, Pune	
70.	Ghosh N.	Geophysical methods for engineering and geotechnical problems - An overview	Advanced Training Course Programme "Engineering Geophysics Seismo-techtronics and Seismic Designs" for Geological Survey of India Officers, CWPRS, Pune, December 2004
71.	Saha A.	Gravity method	
72.	Ramteke R.S.	Magnetic method	
73.	Gupta I.D.	Strong motion parameters for characterization of seismic hazard	

No.	Name	Topic	Course Details
74.	Subba Rao Ch.	Seismic refraction, principles and interpretation techniques	Advanced Training Course Programme "Engineering Geophysics Seismo-techtronics and Seismic Designs" for Geological Survey of India Officers, CWPRS, Pune, December 2004
75.	Wadhwa R.S.	Advanced seismic refraction, interpretation techniques and data acquisition	
76.	Wadhwa R.S.	Typical case studies	
77.	Chandrasekhar V.	Electrical resistivity method	
78.	Chaudhari M.S.	Underwater seismics	
79.	Vaidya S.D.	Borehole logging	
80.	Gupta I.D.	Determination approach for seismic hazard analysis	
81.	Gupta I.D.	Probabilistic approach for seismic hazard analysis	
82.	Kamble R.K.	Tracer techniques	
83.	Bhowmik S.	Borehole seismic studies	
84.	Gupta I.D.	Seismic zoning	
85.	Mukhopadhyay Raja	Seismic and electrical tomography	
86.	Rani C.K.	Ground penetrating radar	
87.	Sinharay Rajib K.	Electromagnetic method	
88.	Ghosh N.	Seismic reflection	
89.	Vaidya S.P.	Jal gunata ke vividh pahalu (hindi)	Hindi Workshop NWA, Pune, January 2005
90.	Chavan A.R.	Cost optimization through use of pumps as turbines in mini & micro hydel projects	II nd Induction Training Programme for Directly Recruited Engineers of NTPC, NWA, Pune, January 2005
91.	Agrawal A.K.	Selection and design of gates and valves for mini & micro hydel projects	
92.	Deolalikar P.B.	Importance of model studies in design of dams	Training Programme on Analysis and Design of Concrete, Masonry, Earth & Rockfill Dams, NWA, Pune, February 2005
93.	Pattanur L.R.	Finite element modelling formulation for stress analysis	
94.	Bendre V.M.	Need for water management	Science Day, National Centre for Grapes, Pune, February 2005
95.	Deshmukh D.N.	Reservoir sedimentation for predicting the life of reservoir	Training Programme on Analysis and Design of Concrete, NWA, March 2005

No.	Name	Topic	Course Details
96.	Gupta I.D.	Fundamentals of structural dynamics	Training Programme onAnalysis and Design of Concrete, Masonry and Earth & Rockfill Dams, NWA, Pune, March 2005
97.	Bhosekar V.V.	Hydraulic design of spillway	
98.	Gupta I.D.	Dynamic analysis of concrete gravity dam	
99.	Bhore M.P.	Dynamic properties of soil and triaxial tests - sampling and testing Part-I	
100.	Muralidhar B.	Dynamic properties of soil and triaxial tests - sampling and testing - Part-II	
101.	Kamble R.K.	Tracer techniques for identifying seepage in dams	
102.	Tongaonkar P.B.	Dynamic analysis of earth and rockfill dams	
103.	Oak R.A.	Scour phenomena	Session No.522 - Senior Professional Course (Bridges & General) for SG & JA Grade Officers,IRICEN, Pune, March 2005
104.	Bhore M.P.	Assessment of liquefaction potential of foundation soils of dam	Training Programme on Analysis and Design of Concrete, Masonry and Earth & Rockfill Dams, NWA, Pune, March 2005
105.	Shirke J.M.	Seepage control measures in earth & rockfill dams	
106.	Shirke J.M.	Alkali-aggregate and the action in concrete : preventive measures and rehabilitation	
107.	Sathe A.K.	Retrofitting / strengthening of dams using epoxy system	
108.	Kudale M.D.	Coastal erosion and protection – Post tsunami scenario	Seminar on “Tsunami and Coastal Protection” held at Centre for Earth Science Studies (CESS), Thiruvananthapuram, February 2005
109.	Kudale M.D.	Impact of port development on the coastline and the need for protection	Third Indian National Conference on “Harbour and Ocean Engineering INCHOE 2004”, Goa, December 2004

TECHNICAL REPORTS

4098 Mathematical model (1D) and desk studies for the development of Naval Dock Yard extension Project in Visakhapatnam Inner Harbour, Andhra Pradesh

4099 Electrical resistivity survey for Tapovan Vishnugad Hydroelectric Project, Uttaranchal (Interim Report)

4100 Studies on stability of bunds forming ash pond No.1&2 for heavy water plant at Manuguru, Andhra Pradesh

4101 Cross-hole seismic studies for Kakrapar Atomic Power Project (Units 3&4), Gujarat (Interim Report)

4102 Inspection of site for training the river Gandak at Dumaria Ghat, Bihar

4103 Dredging & siltation in Sogal channel at Kandla Port (August 2002 to October 2003), Gujarat

4104 Measurement of in-situ stresses and deformability of rock mass in additional surge gallery & extension of head race tunnel section between service gate shaft to Ch 1200M of Koyna Hydroelectric Project, stage IV, Maharashtra

4105 Mathematical model studies for sea water intake discharge system for Chennai Petroleum Corporation Ltd., Chennai, Tamil Nadu

4106 Status of water availability and location of intake for proposed captive power plant II, Bhilai, Chhattisgarh

4107 Tomographic studies for Kakrapar Atomic Power Project (Units 3 & 4), Gujarat (Interim Report)

4108 Restricted

4109 Hydraulic model studies for the proposed complex for cricket - football stadium on Yamuna river bank along Delhi - Noida flyway, New Delhi

4110 Dynamic properties of rock core samples from Kakrapar Atomic Power Project, (Units 3&4), Gujarat

4111 Acoustic logging at Kakrapar Atomic Power Project, (Units 3&4), Gujarat

4112 Hydraulic model studies for the proposed road bridge across river Yamuna about 800m downstream of Wazirabad barrage, New Delhi

4113 Field investigations and model studies for deepening and widening of Indira dock harbour wall berths, Maharashtra

4114 Hydraulic model studies for extension of Jetty at Karanja, Mumbai, Maharashtra

4115 Wave data collection and analysis at Jawaharlal Nehru Port, Mumbai, Maharashtra

4116 Electrical resistivity survey for Kakrapar Atomic Power Project (Units 3&4), Gujarat (Final Report)

4117 Cross hole seismic studies Kakrapar Atomic Power Project (Units 3&4), Gujarat (Final Report)

4118 Tomographic studies for Kakrapar Atomic Power Project (Units 3&4), Gujarat (Final Report)

4119 Model studies for extension of guide bunds of proposed road and rail bridges on Kosi river, Nirmali, Bihar

4120 Studies for the proposed Jetties at Okha and Beyt Dwarka, Gujarat (Final Report)

4121 Studies for raw water intake for Bhushan steel and strips limited on river Brahmni, Orissa

4122 Wave flume studies for the design of cross-sections of the proposed breakwater at Mandwa Port, Maharashtra

4123 Mathematical model studies for design of breakwater layout for Mandwa Port, Maharashtra

4124 Electrical resistivity logging at Kakrapar Atomic Power Project (Units 3&4), Gujarat

4125 Rock mechanics studies to determine shear strength parameters of foundation rockmass for Upper Tunga Project, Karnataka

4126 Hydraulic model studies for irrigation bypass tunnel and gate, Sardar Sarovar Project, Gujarat

4127 Cross hole and tomographic studies for Rajasthan Atomic Power Project (Units 7&8), Rawatbhata, Rajasthan (Interim Report)

4128 Dynamic properties of rock core samples from Rajasthan Atomic Power Project, (Units 7&8), Rawatbhata, Rajasthan

4129 Electrical resistivity logging at Rajasthan Atomic Power Project (Units 7&8), Rajasthan

4130 Water and tailing material quality studies in and around KIOCL area - pre monsoon study, Karnataka

4131 Cross hole seismic studies at Tarapur Atomic Power Station (Units 1&2), Boisar, Maharashtra (Final Report)

4132 Mathematical model studies to assess the impact of reclamation on the monuments in Agra, Uttar Pradesh (Interim Report)

4133 Hydraulic model studies for Subansiri lower dam spillway, Arunachal Pradesh, Assam

4134 Additional hydraulic model studies for performance of Tala dam spillway, Bhutan

4135 Studies for intake well on river Gumti for proposed Tripura gas based power Project, NEEPCO, Tripura

4136 Studies on stability of bunds forming ash pond No.1&2 for heavy water plant at Munuguru, Andhra Pradesh

4137 Acoustic logging at Rajasthan Atomic Power Project (Units 7&8), Rajasthan

4138 Mathematical model (1D) and desk studies for the development of training works of Varsoi creek in Alibag, Maharashtra

4139 Studies for intake well of paper mill of J.K. Corporation Ltd., in river Nagaveli at Jaykaypur, Orissa

4140 Report on ultrasonic non-destructive studies for assessment of quality of in-situ concrete of 25 MW TG foundation of Unit No.6, Rourkela steel plant, Sail, Orissa

4141 Studies for desilting basin for 280/500 MW Tripura gas based power Project at Monarchak, Tripura

4142 Electrical sounding and profiling survey for Rajasthan Atomic Power Project (Units 7&8), Rawatbhata, Rajasthan (Interim Report)

4143 Studies for river regulatory measures for improvement of draft in Hoogli estuary (Part-III), 3-D mathematical model study, West Bengal

4144 Desk studies for assessing the hydraulics of tunnel spillway of Lakya dam at Kudremukh, Karnataka

4145 Hydrological studies for Kudremukh Iron Ore Mines, Karnataka

4146 Cross-hole and tomographic studies for Rajasthan Atomic Power Project (Units 7&8), Rawatbhata, Rajasthan (Final Report)

4147 Seismic reflection survey for development of naval harbour at Visakhapatnam, Andhra Pradesh (Interim Report)

4148 Dynamic properties of rock cores from Rajasthan Atomic Power Projects, (Units 7&8), Rawatbhata, Rajasthan

4149 Hydraulic model studies for Sewa dam spillway, Stage II, Jammu & Kashmir

4150 Desk studies for safety & stability of Lakya earth dam at Kudremukh, Karnataka

4151 Desk studies on stability of hill slopes in mining area at Kudremukh Iron Ore mine, Karnataka

4152 Hydraulic model studies for flushing of the sediment from reservoir - Subansiri lower Hydroelectric Project, Assam, Arunachal Pradesh

4153 Temperature analysis of the Upper dam with reference to cracks development - Ghatghar pumped storage scheme, Maharashtra

4154 Studies for location and design of intake well for Mouda power Project near Nagpur, Maharashtra

4155 Liquefaction potential assessment of foundation of Kachch branch canal from Ch.20 to 112.5 km, Sardar Sarovar (Narmada) Project, Gujarat

4156 Measurement of in-situ stresses and deformability of rock mass in extension of head race tunnel section between Ch 1200m to Ch 4000m of Koyna Hydroelectric Project, Stage IV, Maharashtra

4157 Estimation of site specific ground motion for earthquake resistant design of earthen embankments of Kutchch branch canal, Gujarat

4158 Seismological studies for Tala Hydroelectric Project for the period January 2002 to December 2003, Bhutan

4159 Estimation of site specific design seismic parameters for Upper Beda Project, Madhya Pradesh

4160 Estimation of strength, thermal properties and suitable placement temperature for the modified mix of roller compacted concrete - Ghatghar pumped storage scheme, Maharashtra

4161 Hydraulic model studies for wave tranquility and littoral drift behaviour for the proposed fisheries harbour at Kulai, Mangalore, Karnataka

4162. Nuclear density logging for measurement of in-situ bulk density of masonry at Dudhganga dam, Maharashtra

4163 Determination of dynamic properties of rock cores for Nuclear Island of prototype fast breeder reactor Project at Kalpakkam, Tamil Nadu

4164 Electrical resistivity logging at Rajasthan Atomic Power Project (Units 7&8), Rajasthan

4165 Restricted

4166 Field studies for rating of Tungabhadra right bank canal, Tungabhadra dam Project, Karnataka

4167 Water and tailing material quality studies in and around KIOCL area - Mansoon study, Karnataka

4168 Electrical sounding and profiling survey for Rajasthan Atomic Power Project (Units 7&8), Rawatbhata, Rajasthan (Final Report)

4169 Report on estimation of safe charges and blasting patterns for excavation of rock at PFBR site, Kalpakkam, Tamil Nadu

4170 Hydraulic model studies for Omkareshwar dam spillway, 1:50 scale 2-D sectional model, Madhya Pradesh

4171 Determination of quality of concrete using non-destructive techniques, in upper dam Ghatghar Project, Maharashtra

4172 Performance evaluation of Francis Turbine Units at Salal Hydroelectric Project, Jammu and Kashmir (Final Report)

4173 Acoustic logging at Rajasthan Atomic Power Project (Units 7&8), Rajasthan (Final Report)

4174 Setting up a mathematical model for wave transformation along the approach channel to Jawaharlal Nehru Port, Maharashtra

4175 Reservoir siltation studies for lower and upper lakes of CFA at Kateri, Tamil Nadu

4176 Mathematical model studies to optimize the layout of harbour for all weather Port at Redi, Sindhudurg, Maharashtra

4177 Field data collection and analysis for the proposed Marine Oil Terminal in Pathfinder creek at Vadinar, for M/s Essar Oil Ltd, Gujarat

4178 Desk studies for installation of location on intake structure in Ennore Port basin for NCTPS, Tamil Nadu

4179 Mathematical model studies for tidal hydrodynamics and sediment movement for development of Port at Androth, Lakshadweep

4180 Model studies for UJH level crossing, Jammu & Kashmir

4181 Feasibility studies for cooling water system for joint return power Project of NTPC and TNEB at Chennai, Tamil Nadu

4182 Estimation of site specific design seismic parameters for earthquake resistant design of Kunti dam, Madhya Pradesh

4183 Assessment of the initial feasibility of the schemes for seawater FGD system for Dahanu thermal power station, Maharashtra

4184 Hydraulic model studies for spillway and power intake of Omkareshwar Hydroelectric Project, Madhya Pradesh

4185 Blast studies during excavation of rock near green concrete for 500 MW PFBR Project, Bhavini, Kalpakkam, Tamil Nadu

4186 Mathematical model studies to ascertain the behaviour of moored vessels at Androth Island, Lakshadweep

4187 Physical and mathematical model studies for extension of container (NSICT) berth and other facilities at Jawaharlal Nehru Port, Mumbai, Maharashtra

4188 Hydraulic model studies for spillway and power intake of Teesta low dam Project, Stage-III, West Bengal-1:60 scale 3-D comprehensive model

4189 Estimation of site specific design seismic parameters for Lower Goi Project, Madhya Pradesh

4190 Hydraulic model studies for power intake, Indira Sagar Project, Madhya Pradesh

4191 Studies on roller compacted concrete mix with cement to fly ash ratio 70:150, Ghatghar Pumped Storage Scheme, Maharashtra

4192 Mathematical model studies to assess the impact of reclamations on the monuments along Yamuna river at Agra, Uttar Pradesh

4193 Laboratory studies on rock and roller compacted concrete cores - Ghatghar Pumped Storage Scheme, Maharashtra

4194 Report on hydraulic model studies for power intake of Kuttiyadi Hydroelectric Project in Kerala

4195 Restricted

4196 Installation of weather station and hydromet network for Kol dam Hydroelectric Project of NTPC, Himachal Pradesh

4197 Third party inspection for performance guarantee pump test for 22 pumpsets at Janai, Stage I, II and Shirsai lift irrigation scheme, Maharashtra

4198 Mathematical model studies for development of Jungalighat harbour at Port Blair, Andaman

4199 Development of flood warning system for Loharinag Pala Hydroelectric Project, Uttaranchal

4200 Response of Sogal channel to maintenance dredging at Kandla Port (Apr. 2003 to Mar. 2004), Gujarat

4201 Underwater seismic reflection survey at Jawaharlal Nehru Port, Nhava Sheva, Navi Mumbai, Maharashtra

4202 Mathematical model studies for manoeuvering of Car carriers to Ro-Ro berth at Jawaharlal Nehru Port, Mumbai, Maharashtra

4203 Physical model studies for extension of South breakwater at Paradip Port, Orissa

4204 Studies on concrete mixes for strengthening of the overflow sections of Koyna dam, Maharashtra

4205 Reservoir sedimentation studies for Loharinag Pala Hydroelectric Project, Uttaranchal

4206 Area drainage studies for NTPC-TNEB joint venture Project at Ennore, Tamil Nadu

4207 Estimation of SPE and PMF for Lata-Tapovan Hydroelectric power Project of NTPC, Uttaranchal

4208 Studies for the protection of 36 inch gas pipeline of ONGC in Mindola Creek, Gujarat

4209 Mathematical model studies for wave transformation for inland water transport development at Rajpuri, Janjira fort, Agardanda and Dighi, Maharashtra

4210 Hydraulic model studies for spillway of URI-II, Hydroelectric power Project, Jammu and Kashmir

4211 Hydraulic model studies for flushing of sediment from reservoir Parbati - II, Hydroelectric power Project, Himachal Pradesh

4212 Model studies for the proposed Neradi barrage on river Vamsadhara, Andhra Pradesh

4213 Report on seismic refraction survey at Lata Tapovan Hydroelectric Project, Uttaranchal

4214 Report on electrical resistivity survey at Lata Tapovan Hydroelectric Project, Uttaranchal

4215 Studies for maximum flood estimation, determination of safe grade elevation and storm water drainage for Combined Cycle Power Project (CCPP) at Nagothane, Maharashtra

4216 Additional studies for estimation of design parameters of MMC Syphons on river Banas, Khari II and Sarswati, Gujarat

4217 Assessment of water availability and estimation of floods in Dahuliganga river at Lata Tapovan, Uttaranchal

4218 Hydraulic model studies for drop shaft for Jeeva Nalla diversion works, Parbati Hydroelectric Project, Stage II, Himachal Pradesh

4219 Hydraulic model studies for power intake Omkareshwar Project, Madhya Pradesh.

4220 Submersible pump sets tested for hydraulic performance and overload tests capacity 100 cum/hr, 21m head and 42m head, Uttar Pradesh

4221 Analysis of beach profiles north of Visakhapatnam Port to assess the effect of long term nourishment, Andhra Pradesh

4222 Seismological studies for Teesta HE Project, Stage-VI, for the period Sep. 1998 to Dec. 2003, Sikkim

4223 Prototype strain / stress measure-ments in the penstock bifurcation for Khopoli power house during hydrostatic test at Indian Hume Pipe Factory, Pune, Maharashtra

VISITS OF DIGNITARIES TO CWPRS

It is an honour and privilege to receive dignitaries and show them the capabilities and facilities of CWPRS. Glimpses of visits of some of the important dignitaries are shown below:

Vice Admiral Yashwant Prasad, PVSM, AVSM, VSM, Vice Chief of Naval Staff, New Delhi, visited CWPRS on 10.3.2005. He quoted *"Visiting CWPRS after 35 years. I have observed that the establishment has lived upto its time reputation of providing feasibility study and validating models through a variety of means. The report on Project Victor generally meets our requirements. We shall continue to use the establishment for our solutions. I was extremely happy to see the commitments of the people I met. I wish the Director and her team good luck and best wishes. Thank you for your hospitality."*

Y.N. Apparao, Chairman & Managing Director, Satluj Jal Vidyut Nigam (Formerly NJPC), visited CWPRS on 10.6.2004. He said *"Attend the short course on "Rehabilitation of Distressed Hydraulic Structure" conducted by CWPRS which is a need of the hour with invaluable powers, organized most efficiently and reflects exceptional caliber in research work of water resources. I could see, CWPRS has a dedicated Director and eminent scientists extending research backup to the nation. I wish all of them best of everything in the world."*

Smt. Snehlata Chauhan, Mayor of Surat, alongwith Corporators of Surat Municipal Corporation, visited CWPRS on 22.3.2005 and was highly impressed to see the hydraulic model of river Yamuna at Delhi.

Members of the Technical Advisory Committee to the Governing Council of CWPRS deliberating in the meeting held on 28.1.2005

राजभाषा हिंदी के प्रगामी प्रयोग से संबंधी प्रमुख गतिविधियाँ

हिंदी दिवस तथा हिंदी पखवाड़ा

अनुसंखधान शाला में १४ सितम्बर २००४ को हिंदी दिवस मनाया गया। इस अवसर पर महाराष्ट्र राज्य विद्युत मंडल के मुख्य अभियंता श्री शंकर भगवंत राव देखमुख मुख्य अतिथी के नाते उपस्थित थे। हिंदी पखवाडे के दौरान राजभाषा कार्यान्वयन समिती के मार्गदर्शन में हिंदी निबंध, टंकण प्रश्न-मंच, वाद-विवाद तथा तकनीकी कार्य में हिंदी का प्रयोग आदि प्रतियोगिताओं का आयोजन किया गया। इन प्रतियोगिताओं में अधिकारी एवं कर्मचारी उत्साह से सम्मिलित हुए। भारत सरकार द्वारा लागू मूल रुप में हिंदी में टिप्पण आलेखन पुरस्कार योजना अनुसंधान शाला में लागू की गई थी। इन प्रतियोगिताओं में योग्यता प्राप्त अधिकारी एवं कर्मचारीयों को मुख्य अतिथि के करकमलों द्वारा नकद पुरस्कार एवं प्रमाणपत्र देकर प्रोत्साहित किया गया।

हिंदी पत्रिका ''जलवाणी'' का प्रकाशन

हिंदी दिवस के अवसर पर मुख्य अतिथि के करकमलों द्वारा अनुसंधान शाला की हिंदी गृह पत्रिका जलवाणी के ग्यारहवें अंक का प्रकाशन किया गया जिसमें ५० प्रतिशत से अधिक लेख तकनीकी एवं विभागीय विषयों से संबंधित लेख समाविष्ट किए गए हैं।

राजभाषा प्रोत्साहन चल शील्ड योजना

अधिक से अधिक तकनीकी कार्यालयीन कामकाज राजभाषा हिंदी में करने तथा प्रभागों में स्वस्थ प्रतियोगिता जागृत करने के प्रयोजन से अनुसंधान शाला द्वारा प्रति वर्ष राजभाषा प्रोत्साहन चल शील्ड प्रदान की जाती है। इस वर्ष हिंदी दिवस के अवसर पर यह शील्ड मुख्य अतिथि के करकमलों द्वारा रसायन प्रभाग को प्रदान की गई।

हिंदी कार्यशाला का आयोजन

वार्षिक कार्यक्रम में दिए गए निदेशों के अनुसार अनुसंधान शाला में ४ हिंदी कार्यशालाएँ आयोजित की गई। संघ की राजभाषा नीति, सरकारी पत्राचार के नमूने, टिप्पण-आलेखन एवं भाषा और वर्तनी के बारे में उपयोगी सामग्री प्रशिक्षण कार्यक्रम में सम्मिलित थी इसके अलावा श्री नारायण प्रसाद राजभाषा अधिकारी ने तकनीकी शब्द निर्माण के बारे में विशेष मार्गदर्शन दिया।

कंप्यूटरों में हिंदी साफ्टवेयर

कार्य में तेजी लाने के उद्देश्य से मार्च २००५ ISM V5 नामक द्विभाषी सॉफ्टवेयर की खरीद करके अनुसंधान शाला के नेटवर्क पर उपलब्ध कराया गया है। इसके प्रयोग से अनुसंधान शाला के हिंदी के टंकण कार्य में एकरुपता आएगी। इस सॉफ्टवेयर में प्रशासनिक शब्दकोष समाविष्ट है। प्रयोगकर्ता इसे आवश्यकतानुसार तुरंत अंग्रेजी शब्द का पर्यायवाची शब्द हिंदी में देख सकता है और जिन शब्दों के पर्याय नहीं है। इस सॉफ्टवेयर के प्रयोग से संबंधित प्रशिक्षण कार्यक्रम में अनुसंधान शाला के लगभग ६० कर्मचारीयों ने हिस्सा लिया।

हिंदी वेबसाइट

इस अनुसंधान शाला की वेबसाइट http://cwprs.gov.in बनाई गई है जिसमें संस्था के बारे में जानकारी हिंदी में उपलब्ध कराई गई है। इसे समय-समय पर अद्यतन किया जाता है।

अनुसंधान शाला के इन्ट्रानेट पर हिंदी 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, मत्रालयों/विभागों के नाम, छुट्टियों के प्रकार, वर्तनी, संदेश, गृह पत्रिका जलवाणी, हमेशा प्रयुक्त होने वाले वाक्यांश आदि हिंदी में उपलब्ध कराए गए है।

नियम ८(४) के अधीन हिंदी में कामकाज

अनुसंधान शाला के १९ अधिकारियों /कर्मचारीयों को राजभाषा नियम १९७६ के नियम ८(४) के अधीन टिप्पण प्रारूपण और ऐसे अन्य शासकीय प्रयोजनों के लिए केवल हिंदी का प्रयोग करने के लिए दिनांक १४/८/२००३ के आदेश संख्या ६७५/६/२००३-हिंदी द्वारा नामित किया गया है।

दूसरा अखिल भारतीय जल साहित्य सम्मेलन, पुणे में सहभागिता

साप्ताहिक अभियंता मित्र, पुणे द्वारा दिनांक २१-२२ अगस्त २००४ को गांधी शांति प्रतिष्ठान, दिल्ली के प्रमुख अनुपम मिश्र की अध्यक्षता में संपन्न हुआ। सुप्रसिध्द जल वैज्ञानिक श्री माधवराव जी चितळे ने मार्गदर्शन दिया। इस सम्मेलन में अनुसंधान शाला से १० अधिकारी उपस्थित थे।

सतर्कता जागरूकता सप्ताह का हिंदी में संचालन

अनुसंधान शाला में दिनांक १/११/२००४ से ६/११/२/२००४ तक सतर्कता जागरूकता सप्ताह मनाया गया।

राष्ट्रीय संगोष्ठी में सहभागिता

११ मार्च २००५ को केन्द्रीय मृदा एवं सामग्री अनुसंधान शाला, नई दिल्ली में ''जल संसाधन परियोजनाओं में अन्वेषण का महत्व एवं चुनौतियाँ'' नामक विषय पर एक राष्ट्रीय संगोष्ठी आयोजित की गई थी। इस संगोष्ठी में अनुसंधान शाला के श्री नारायण प्रसाद, मुख्य अनुसंधान अधिकारी एवं राजभाषा अधिकारी ने ''राजभाषा हिंदी की अपेक्षित प्रगति न होने के कारण एवं निदान'' नामक शोध पत्र प्रस्तुत किया।

विश्व जल दिवस २००५

दिनांक २२ मार्च २००५ को विश्व जल दिवस मनाया गया। इस उपलक्ष्य में २१ मार्च २००५ को अनुसंधान शाला के सभा भवन में हिंदी और मराठी कवि सम्मेलन का आयोजन किया गया।

कॉलोनी कल्याणकारी समिती रिपोर्ट

अनुसंधान शाला कॉलोनी कल्याणकारी समिती की ओर से कॉलोनीवासियों के हित में मुख्य गतिविधियां निम्न प्रकार से रही:

- ''स्वतंत्रता दिवस'' के उपलक्ष्य में खेल प्रतियोगिताएं सांस्कृति कार्यक्रमों का आयोजन किया गया।
- ''सद्भावना दिवस'' के अवसर पर कालोनी के बचों द्वारा एक सद्भावना संदेश रैली निकाली गई।
- महाराष्ट्र के बढग्रस्त गांवों तथा भूकंप पीडितों को पुस्तकें, नोटबुक्स, कपडे एवं आवश्यक खाद्य सामग्री की मदद की गई।
- बचों एवं कर्मचारी वर्ग के लिए रंगमंच से जुडे श्री मनोहर खुशलानी के निर्देशन में ''ड्रामा एवं व्यक्तित्व'' विकास शिबिर का आयोजन किया गया।
- ''रिमझिम बालक मंदिर'' मराठी शाला में बचों के सर्वांगिण विकास को ध्यान में रखते हुए अध्ययन के साथ विभिन्न त्यौहारों को मनाते हुए भारतीय संस्कृति से अवगत कराया गया। होन-हार बचों को श्री एस.जी. पटनायक, संयुक्त निदेशक द्वारा पुरस्कार दिए गए।
- ''गणतंत्र दिवस'' के उपलक्ष्य में चित्रकला, खेल कूद एवं सांस्कृतिक कार्यक्रमों का आयोजन किया गया। इस अवसर पर ''फुड फेस्टिवल'' का आयोजन किया गया। माननीय निदेशक महोदया के कर कमलों द्वारा बचों को पुरस्कार वितरण किया गया।

विभिन्न महोत्सव जैसे कि गणेश उत्सव, इस्टर, दशहरा, आंबेडकर जयंती, शिव जयंती आदि मनाने हेतु प्रोत्साहन दिया गया।







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CENTRAL WATER AND POWER RESEARCH STATION
Khadakwasla, Pune - 411 024, India

- Tel. : 020 - 24380511, 24380825, 24381801
- Fax : 020 - 24381004
- E-mail : director@cwprs.gov.in
- Web : http://cwprs.gov.in