Maharashtra Engineering Research Institute, Nashik.

WEL-COMES YOU !!!
MIX DESIGN OF
ROLLER COMPACTED CONCRETE
FOR
GHTAGHAR PROJECT –
A OVERVIEW

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Director General    S. E. & Jt. Director   Sci. Research Officer

Maharashtra Engineering Research Institute., Nashik
• Ghatghar Pumped Storage Scheme is the first monument in the history of India, as a first project constructed with new concrete technology of RCC.

• It was taken up as Technical Demonstration Project by FAUP, New Delhi and Govt. of Maharashtra to demonstrate and understand the RCC and methodology of construction etc.

• Many agencies are associated for co-ordination, guidance, planning, design, research, construction etc. Efforts of Mr. Vimal Kumar, Director, FAUP has resulted in three RCC dams under Ghatghar Project.
• Govt. of Maharashtra has shown courage to do this experiment in Maharashtra giving opportunity to his officers to show their technical best.

• This was a team work and Chief Engineer, Koyna Project and his construction officers made it grand success with the help of other supporting agencies.

• RCC is very very different from conventional concrete. It is very sensitive to slight change in any of the properties of materials and ambient temperature. Construction technique is simple, but the methods should be followed sequentially.
RCC - A NEW CONCRETE

RCC is a zero slump concrete delivered by dumpers or conveyors, spread by bulldozers in horizontal layers and compacted by vibratory rollers in thin lifts - not exceeding 300mm to 600mm – from one abutment to other.

Concrete must be dry enough to support the weight of vibratory rollers and wet enough to permit distribution of paste throughout the mass.

Desired density is measured in-situ by Nuclear densometer and is achieved by adjusting no. of passes of vibratory rollers.

Construction is economical and rapid.

Apart from these, RCC has high potential of large scale utilization of fly ash whose safe disposal at present is a grave environmental concern.

Use of RCC has allowed many new dams in the world to become economically feasible at reduced cost and time realised from low cement and large fly ash content and rapid construction.
ROLE OF M.E.R.I., NASHIK

• MERI, Nashik was associated with this Project for
  i) Testing of construction materials, right from water to hardened concrete,
  ii) Mix design of RCC

• MERI has done lot of mix designs in conventional concrete with and without use of fly ash.

• But this RCC concrete having no-slump (zero slump) consistency and compacted by vibratory rollers was new concrete to design.

• A workshop was organized to get acquainted with this technique.
A workshop on “Roller Compacted Concrete Dam” was organised in Nov. 1995 to understand RCC, construction and RCC dams for Research and Construction officers in India.

Workshop was conducted by Mr. Ernest Schrader, an UNDP consultant.

He visited the Ghatghar project site and gave technical specifications for laying of RCC, mix design, planning of the project, construction methodology etc.
• Mr. Schrader gave guidance on basics of mix design to MERI, Nashik.

• Lessons were learnt and mix design methodology was developed in MERI, Nashik.

• He guided mix designs for Upper dam with low paste concrete and for Lower dam with high paste concrete.

• However, it was said that adoption of high paste RCC is best suited to Newcomers in this field and tropical countries like India. Low paste require patience and experience in RCC construction.
Material Used:

- Cementitious content: 80 & 150 kg/cum
- Cement: 43 grade cement
- Fly ash: Nashik TPS
- Coarse aggregate: 40-20, 20-5mm from Lower dam site
- Fine aggregate: 25% natural sand + 75% crushed stone sand.
- Mixes were carried out as directed by the Consultant with following proportions and tested up to 365 days for various properties such as density, compressive strength, spilt tensile strength, Young Modulus, permeability etc.
i) For cementitious content 150 kg/cum.
   • 50% fly ash with varying water contents
     [ Optimum (70 lit) ± 0.4% & 0.8% ].
   • 50% fly ash with addition of Stone dust fines
     at 3% & 6%.

ii) For cementitious content 80 kg/cum.
   • 30%, 50%, & 70% fly ash substitution.
   • 50% fly ash with varying water contents.
   • 50% fly ash with varying Stone dust fines.
   • 50% fly ash with addition of admixture.
     (0.4% to 1.6%)
Mix designs were carried out for 115, 150, 185 and 220 kg/cum cementitious content.

i) For c. c. 115 & 185 kg/cum.
   - 30%, 50% & 70% fly ash

ii) For c.c. 150 kg/cum
   - 30%, 50% & 70% fly ash
   - 30%, 50% & 70% fly ash with varying water content

iii) For c. c. 200 kg/cum
   - 30%, 50% & 70% fly ash
   - 50% fly ash with addition of stone dust fines.
   - 50% fly ash with admixture
ELECTRIC POWER DEVELOPMENT CO.

INTERNATIONAL LTD (EPDCIL), Japan was appointed as new consultant who has large experience in building of RCC dams in Japan.

EPDCIL has abandoned the mix designs of Mr. Schrader and set the parameters for mix design as

- High paste RCC
- Layered construction with monoliths.
- GEVR concrete membrane of 2m width @ U/P & D/P side ends.
- 50 MSA aggregate & 100% crushed sand.
- Cohesive mix without segregation.
- 150 kg/cm² compressive strength at 90 days age.
- Density more than 2.5 T/cum.
- Satisfactory impermeability.
OBJECTIVES SET FOR MIX DESIGN

- Optimize the gradation of the aggregates with maximum size of aggregate.
- Optimize the workability and define the water content for the RCC mix.
- Define minimum cementitious content commensurate with cohesive mix.
- Optimize fly ash content to get desired results.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimum crushed sand</td>
<td>35% by weight of the total aggregate.</td>
</tr>
<tr>
<td>MSA of Aggregate</td>
<td>53mm</td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td>50-20mm, 20-10mm and 10-5mm</td>
</tr>
<tr>
<td>Optimum workability</td>
<td>Ve Be time of 25 sec.</td>
</tr>
<tr>
<td>Water content</td>
<td>Initially 115 lit/cum.</td>
</tr>
<tr>
<td>Fly ash substitution</td>
<td>From 30% to 70% by weight of the cementitious content.</td>
</tr>
<tr>
<td>Fly ash</td>
<td>Nashik thermal Power Station, Nashik.</td>
</tr>
<tr>
<td>Cementitious content</td>
<td>220 kg/cum</td>
</tr>
<tr>
<td>Grade of cement</td>
<td>43 grade.</td>
</tr>
<tr>
<td>Admixture</td>
<td>PLASTIMENT–R admixture</td>
</tr>
<tr>
<td>Dose of admixture</td>
<td>0.88% by weight of cementitious material fixed on laboratory trials</td>
</tr>
</tbody>
</table>
• **Gradation of coarse aggregate:** Aggregates were internally proportioned for various percentage combinations to achieve maximum dry rodded density to get minimum voids and dense concrete as suggested by EPDCIL.

• The overall gradation of 50-20 : 20-10 : 10-5mm aggregate arrived at proportion 52 :26.40 : 21.60

• 23 Mixes were conducted for c.c. 200 kg/cum with 30% to 70% fly ash substitution and various properties were observed up to 365 days.
Workability is measured by Ve Be Apparatus.

Concrete is placed in cylindrical jar of 23 cm diameter by 23 cm height. Round metal weight of 10 kg is placed on the concrete and vibrated until the cement slurry comes out around the weight. This indicates that the concrete is fully compacted and additional remaining slurry comes out. The time elapsed is called as Ve Be time, which is the measure of workability. Instrument will be shown in the photographs at end of narration.

For a good RCC mix, this time shall be 25 to 30 seconds.
Conclusions of EPDCIL mixes

- Ve Be time observed in the range of 25 to 30 sec indicating cohesive mix.
- Density was more than desired 2.5 T/cum.
- Modulus of Elasticity comparable to conventional concrete.
- All specimen gave compressive strength more than the desired value 150 kg/cm2.
- Permeability of all specimen was satisfactory.
CONSULTATION WITH M D & A, UK

- EPDCIL consulted Malcolm Dunstan & Associates of UK and as per his suggestion, 17 additional mixes for cementitious contents 180, 200, 220 & 240 kg/cum and 40% to 70% fly ash substitution were carried out and test results are as follows.

- He suggested to adopt design age of 180 days at proto as structure will not fully loaded for some time after completion and a reasonably high amount of fly ash likely to be used.
## TEST RESULTS

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of the Test</th>
<th>Permissible limits</th>
<th>Achievements in Lab.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Workability</td>
<td>25 - 30 sec</td>
<td>25 - 30 sec.</td>
</tr>
<tr>
<td>2</td>
<td>Density</td>
<td>2500 kg/m³ &gt; 2500 kg/m³</td>
<td>&gt; 2500 kg/m³</td>
</tr>
<tr>
<td>3</td>
<td>Permeability</td>
<td>10^{-7} to 10^{-13} m/sec</td>
<td>Impervious</td>
</tr>
<tr>
<td>4</td>
<td>Modulus of Elasticity</td>
<td>1.4 to 5.0 x 10^5 kg/cm²</td>
<td>1.5 to 4.2 x 10^5 kg/cm² (as Conventional concrete)</td>
</tr>
<tr>
<td>5</td>
<td>Compressive strength</td>
<td>150 kg/cm² at 91 days</td>
<td>(given on next slide)</td>
</tr>
</tbody>
</table>
Regarding Compressive strength, it was observed that:

- Compressive strength goes on falling beyond 60% fly ash.
- Mixes with 70% fly ash replacement are not able to achieve prescribed strength.
- All the mixes with 180 kg/m³ cementitious content are not able to achieve the prescribed strength.
- The mixes with cementitious content of 200, 220 and 240 kg/m³ with 40% to 70% cement replacement by fly ash are able to achieve the prescribed strength.
% FLY ASH Vs COMPRESSIVE STRENGTH FOR C. C. 180 kg/Cum

Graph No. 1
GRAPH NO. 2

% FLY ASH Vs COMPRESSIVE STRENGTH FOR C. C. 200 kg/Cum

COMPRESSIVE STRENGTH IN kg/sq.cm

% FLY ASH

365 DAYS
180 DAYS
91 DAYS
28 DAYS
GRAPH NO. 3

% FLYASH Vs COMPRESSIVE STRENGTH FOR C.C. 220 kg/cum

COMpressive Strength IN Kg/sq.cm

20 30 40 50 60 70 80 90

% FLY ASH
GRAPH NO. 4

% FLY ASH Vs COMPRESSIVE STRENGTH FOR C. C. 240 kg/Cum

% FLY ASH

COMPRESSIVE STRENGTH IN kg/sq.cm

40 45 50 55 60 65 70 75

365 DAYS
180 DAYS
91 DAYS
28 DAYS
In nutshell, it is seen that,

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Cementitious content kg/m³</th>
<th>Fly ash required %</th>
<th>Cement required kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200</td>
<td>60.00</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>220</td>
<td>66.75</td>
<td>73</td>
</tr>
<tr>
<td>3</td>
<td>240</td>
<td>65.00</td>
<td>84</td>
</tr>
</tbody>
</table>

Note: 220 Kg/m³ cementitious content with a maximum 66.75% fly ash replacement and minimum consumption of cement is economical.
RCC Mix of 220 kg/m³ cementitious content with following ingredients was finalized.

### Ingredients used for one cum of concrete

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Cement</th>
<th>Flyash</th>
<th>Sand</th>
<th>Coarse aggregate in kg</th>
<th>Water</th>
<th>Admixture</th>
<th>w/c Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg</td>
<td>kg</td>
<td>kg</td>
<td>50-20</td>
<td>20-10</td>
<td>10-5</td>
<td>mm</td>
</tr>
<tr>
<td></td>
<td>88</td>
<td>132</td>
<td>714</td>
<td>769</td>
<td>390</td>
<td>319</td>
<td>115</td>
</tr>
</tbody>
</table>

(40%)(60%)

Note: For practical purposes, 66.75% of fly ash is rounded to 60% with corresponding cement to 40%
SUITABILITY FOR VARIOUS 10 FLY ASHES

• This mix design is prepared for one location i.e. fly ash from Nashik TPS.

Following fly ashes were tested for suitability in above final mix design in case supply of tested fly ash would not be available during the construction:

i) Fly ash from five different hoppers of Nashik Thermal power station.

ii) Fly ash from three locations of Dahanu TPS of Reliance Energy Ltd.

iii) Processed fly ash of Nashik TPS by Dirk India Ltd under name Pozzocrete 63 & 83 grade

• 10 mixes were carried out for above 10 fly ash using final approved mix design.
It was observed that:

- All fly ashes satisfy the prescribed criteria
- Dahanu fly ash give more strength than Nashik fly ash
- Pozzocones give more strength than prescribed, even at 56 days.
This can be seen from table below and following graph

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Location of Fly ash</th>
<th>Compressive strength at 91 days in kg/cm²</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nashik TPS</td>
<td>149 to 161</td>
<td>Av. 154 at 91 days</td>
</tr>
<tr>
<td>2</td>
<td>Dahanu TPS</td>
<td>152 to 186</td>
<td>Av 167 at 91 days</td>
</tr>
<tr>
<td>3</td>
<td>Pozzocrete 63 grade</td>
<td>189</td>
<td>167 at 56 days</td>
</tr>
<tr>
<td>4</td>
<td>Pozzocrete 83 grade</td>
<td>235</td>
<td>177 at 28 days</td>
</tr>
</tbody>
</table>

Note: Pozzocretes give more strengths at early days. Hence, there is a scope of reducing the pozzocrete grade below 63 and thereby reducing the cost of Pozzocrete.
Compressive Strength of RCC specimen using Fly ashes and Pozzocrete for various ages.
**Final Mix design adopted**  
*(7/2002)*

RCC mix with 220 kg/m³ cementitious content  
(with Sand-Coarse Aggregate proportion as 35:65)

Ingredients used for one cum of concrete

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>88 kg</td>
<td>(40%)</td>
</tr>
<tr>
<td>Fly ash</td>
<td>132 kg</td>
<td>(60%)</td>
</tr>
<tr>
<td>Sand</td>
<td>714 kg</td>
<td></td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td>769 mm</td>
<td></td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td>390 mm</td>
<td></td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td>319 mm</td>
<td></td>
</tr>
<tr>
<td>Water admixture</td>
<td>115 Lit</td>
<td></td>
</tr>
<tr>
<td>W/c ratio</td>
<td>0.88</td>
<td>0.52</td>
</tr>
</tbody>
</table>

RCC mix with 220 kg/m³ cementitious content  
(with Sand-Coarse Aggregate proportion as 35:65)

Proportion  
1 : 1.5 : 8.1 : 16.80 -  
comes to  
(C) (F) (S) (A)

Such a lean mix satisfies the prescribed requirement of workability, density, strength and impermeability.
Trial test Sections 1 or 2 shall be constructed at site to observe the efficacy of laboratory mix, methodology, understanding laying of RRC, working of equipments, checking the properties of proto RCC and training to the staff.

Test section no. 1 (March 2002):
(10m wide x 50m long x 3 layers of 300mm)

Based on MERI’s final mix design, Trial Test Section no. 1 was constructed at Upper dam site.

The results of test section were not satisfactory on account of change in specific gravity of aggregate and sand that was anticipated in the mix design.

However, the exercise was successful in understanding methodology and sequence of operation and training the staff.
Keeping the cementitious content same and corrections made in other parameters like gradation of aggregate, sand/aggregate ratio, specific gravity etc., about 130 mix trials were conducted in field laboratory and following mix proportions was finalized

<table>
<thead>
<tr>
<th>Ingredients in kg for one cum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>88</td>
</tr>
<tr>
<td>(40%)</td>
</tr>
</tbody>
</table>
Trial Test Section no. 2 of size 10m x 50m in three layers of 300mm thickness was constructed at Upper dam site. Temperature measurement, density by Nuclear density gauge, no. of passes required to achieve the desired density, treatment of cold joint, crack inducer, GEVR compaction etc were recorded. Though, there was increase in strength of specimen and in-situ drilled cores, test section was not successful in getting a continuous drilled core due to segregation observed at lift joints.
At this juncture, Malcolm Dunstan & Associate, UK was appointed to guide the site specific mixes and construction work.

Under his guidance, mixes were carried out at MERI and on site to optimize the gradation and workability and following mix design was finalised.

<table>
<thead>
<tr>
<th>Cement</th>
<th>Fly ash</th>
<th>Crushed sand</th>
<th>Coarse aggregate 50-20</th>
<th>Coarse aggregate 20-10</th>
<th>Coarse aggregate 10-5</th>
<th>Water</th>
<th>Admixture %</th>
</tr>
</thead>
<tbody>
<tr>
<td>88</td>
<td>132</td>
<td>692</td>
<td>558</td>
<td>446</td>
<td>406</td>
<td>135</td>
<td>1.20</td>
</tr>
<tr>
<td>(40%)</td>
<td>(60%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This mix was laid on the old concrete of Test Section 2 and satisfactory results were obtained. Same was used in Saddle dam.

**SADDLE DAM (11.5m high, 258m long)**

19 layers of 300mm compacted thickness with total 6780 cum RCC on LHS was carried between 9-27 March 2003 and second half at RHS consisting of 7438 cum RCC was completed between 22 April to 9 May 2003. Total 14218 cum of concrete was placed in 36 days. Av. in-situ density of 2568 kg/cum, av. cylinder compressive strength of 204 kg/cm² and in-situ permeability below one lugeon was the outcome the RCC work done at Saddle dam.

1900 MT fly ash was utilised in Saddle dam. This is the first dam in which such large quantity of fly ash has been utilised. This was a full scale trial which gave confidence to the team.
CONSTRUCTION OF
UPPER DAM (in 54 days)
(14.5m high and 451 length)

With slight corrections, following Mix designs were adopted in various layers of Upper dam:

<table>
<thead>
<tr>
<th>Mix</th>
<th>Cement</th>
<th>Fly ash</th>
<th>Crushed sand</th>
<th>Coarse aggregate</th>
<th>Water</th>
<th>Admixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G85</td>
<td>88</td>
<td>132</td>
<td>692</td>
<td>558</td>
<td>446</td>
<td>404</td>
</tr>
<tr>
<td>G100A</td>
<td>88</td>
<td>132</td>
<td>692</td>
<td>558</td>
<td>446</td>
<td>404</td>
</tr>
<tr>
<td>G150</td>
<td>88</td>
<td>132</td>
<td>726</td>
<td>588</td>
<td>468</td>
<td>423</td>
</tr>
</tbody>
</table>

Upper dam was completed in June 2004 with placement of 35,576 cum concrete in 54 days. Fly ash utilised is about 4,700 cum. Upper dam has Gated Central spillway in conventional concrete.

In-situ density obtained was 2540 kg/cum and compressive strength of 181kg/cm².
CONSTRUCTION OF LOWER DAM (expected in 15 months) 
(86m high and 415m length)

Mix design adopted at the start of construction was as follows:

<table>
<thead>
<tr>
<th>Cement</th>
<th>Fly ash</th>
<th>Crushed sand</th>
<th>Coarse aggregate</th>
<th>Water</th>
<th>Admixture</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>88</td>
<td>132</td>
<td>762</td>
<td>641</td>
<td>415</td>
<td>464</td>
<td>115</td>
</tr>
<tr>
<td>(40%)</td>
<td>(60%)</td>
<td>(40%)</td>
<td>(60%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

More fly ash was incorporated subsequently and cementitious content was changed to 75+160.

Construction was started in 14 Dec. 2004 and is expected to completed by end of May 2006 in just 15 working months.

Expected volume of concrete for Lower dam is 6 lakh cum.

Total consumption of fly ash for these 3 dams would be 1 lakh MT.
EXPERIENCE GAINED FROM THIS PILOT PROTO MODEL

RCC concrete is very susceptible to any slight deviation in material properties.

Selection of max. size and gradation of aggregate are important factors influencing quality and properties of RCC.

Void content ranges between 34% to 42%.

Paste/mortar ratio shall be more than 0.38

Optimum fine aggregate content is 35%

Water content directly affects the compactive efforts required to achieve full consolidation.
Upper & lower limit of water content considered for RCC is 115 to 145 liters, with an optimum of 130 liters. Trial test section shall be constructed prior to main dam construction.

Advantage of using admixtures is to enhance workability and set retard for keeping mass concrete alive and preventing cold joints.

Site specific mix design shall be carried out by re-proportioning the aggregate, water and admixture on account of availability of gradation of materials, adequacy of equipments and ambient temperature conditions.

Mix designs were carried out as per guidelines of RCC consultant.

His experienced decisions are in favor of the Dam Owner in selecting parameters, gradation & proportions of aggregate, cementitious content, workability, construction equipments, construction methodology etc. as Owner is new to this technique.
RCC is totally different from the conventional concrete – in mix design, in construction & precautions after laying. It is just like a infant who is susceptible to any slight change in environment & feeding and has to be look after carefully.

Somebody experienced in this field is necessary to guide right from planning, designing and during construction. Dam Owners in India are new to this technique. Dam Owners has to follow this at every time untill sufficient knowledge, experience and training is gained by his each & every construction officer and they are able to take their own decisions.
The experience gained in mix design is put forth in nutshell as follows:

Materials used for RCC consists of water, cementitious material (cement + fly ash), crushed stone sand, coarse aggregates (usually three sizes) and admixture (water reducer and set retarder type). The RCC mix should have sufficient paste volume to fill the internal void of aggregate mass and dry enough to be compacted by vibratory rollers in layers without segregation. The process of proportioning RCC mixes depends on the strength and temperature requirements for design, properties of materials and desired workability.

General steps in proportioning of RCC mix are:

- Select suitable size of aggregate
- Optimise crushed sand and coarse aggregate proportion.
- Optimise aggregate’s proportion to achieve maximum dry rodded density.
- Select the cementitious content and various percentages of cement replacement by fly ash.
- Test all materials as per relevant Indian Standards.
- Optimise workability with a loaded Ve Be time within 20 to 30 sec. Apply necessary moisture content (of aggregates) correction to water requirement.
- Prepare mix and cast cylindrical specimen for testing strength and durability.
- Test cylindrical specimen after curing in water for various ages till 365 days.
- Select the mix proportion that satisfies the desired parameters such as requisite density, compressive strength at 180 or 365 days and impermeability.
- Conduct the final mix proportion for suitability to various fly ash sources, if supply of flow of fly ash from one source seems insufficient during the construction.
- Carry out the site specific mix design by re-proportioning the aggregates and water content for workability and admixture dose for set retarding the concrete depending on time required for the conveyance, compaction and placement of next lift.
Trial test section with full scale trials to access the in-situ properties of fresh and hardened concrete for any deviation from requisite requirements.

**Temperature**: The main principal factor affecting uncontrolled cracking of structure is the peak internal temperature reached soon after placement of concrete and average annual ambient temperature to which the mass will eventually cool.

This can be controlled by following measures:

- Optimisation of the properties of cement and fly ash to reduce the heat of hydration up to tolerable limits.
- Reducing peak temperature by lowering the initial placing temperature of concrete through cooling the coarse aggregate by chilled water or ice and use of chilled water.
- Scheduling the construction during winter or at night to minimize temp. rise due to heat absorption.
- Evaporative cooling through constant curing water.
- Post-forming the contraction joints by vibrating steel or plastic crack intruders into the RCC after spreading and compaction.
- Arranging adequate distance between consecutive monoliths.
GENERATION OF ELECTRICITY DURING PEAK HOURS IN GENERATION MODE 6 HOURS DAILY EXCEPT SUNDAY

GENERATING SET:
- GENERATOR RATING: 147 MVA
- MOTOR RATING: 150 MW
- RATED VOLTAGE: 13.8 KV
- RATED SPEED: 500 rpm

TURBINE: REVERSIBLE
- TYPE: FRANSIS, NUMBER -2
- DESIGN HEAD: 420 M
- RATED DISCHARGE: 37.20 CUM/SEC.
- CPAPACITY: 125 MW

PUMP HEAD: 430 M
RATIO LENGTH OF CONDUCTOR SYSTEM TO DESIGN HEAD: 3.20

GENERATING SET:
- GENERATOR RATING: 147 MVA
- MOTOR RATING: 150 MW
- RATED VOLTAGE: 13.8 KV
- RATED SPEED: 500 rpm

KONKAN KADA
- POWER HOUSE COMPLEX
- ELECTRICITY TO THE GRID

UPPER DAM
- UPPER INTAKE STRUCTURE
- UPPER RESERVOIR

LOWER DAM
- LOWER RESERVOIR
- F.R.L. 346
- DRAFT TUBE TUNNEL: 3.5 M. Ø
- TAIL RACE TUNNEL

UPPER DAM
- UPPEL INTAKE STRUCTURE
- UPPER RESERVOIR

CONTROL & POWER CABLE TUNNEL
- DOWN STREAM SURGE TANK: 11 M. Ø
- VENTILATION TUNNEL
- LOWER INTAKE STRUCTURE
In-situ Density by Nuclear densiometer
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