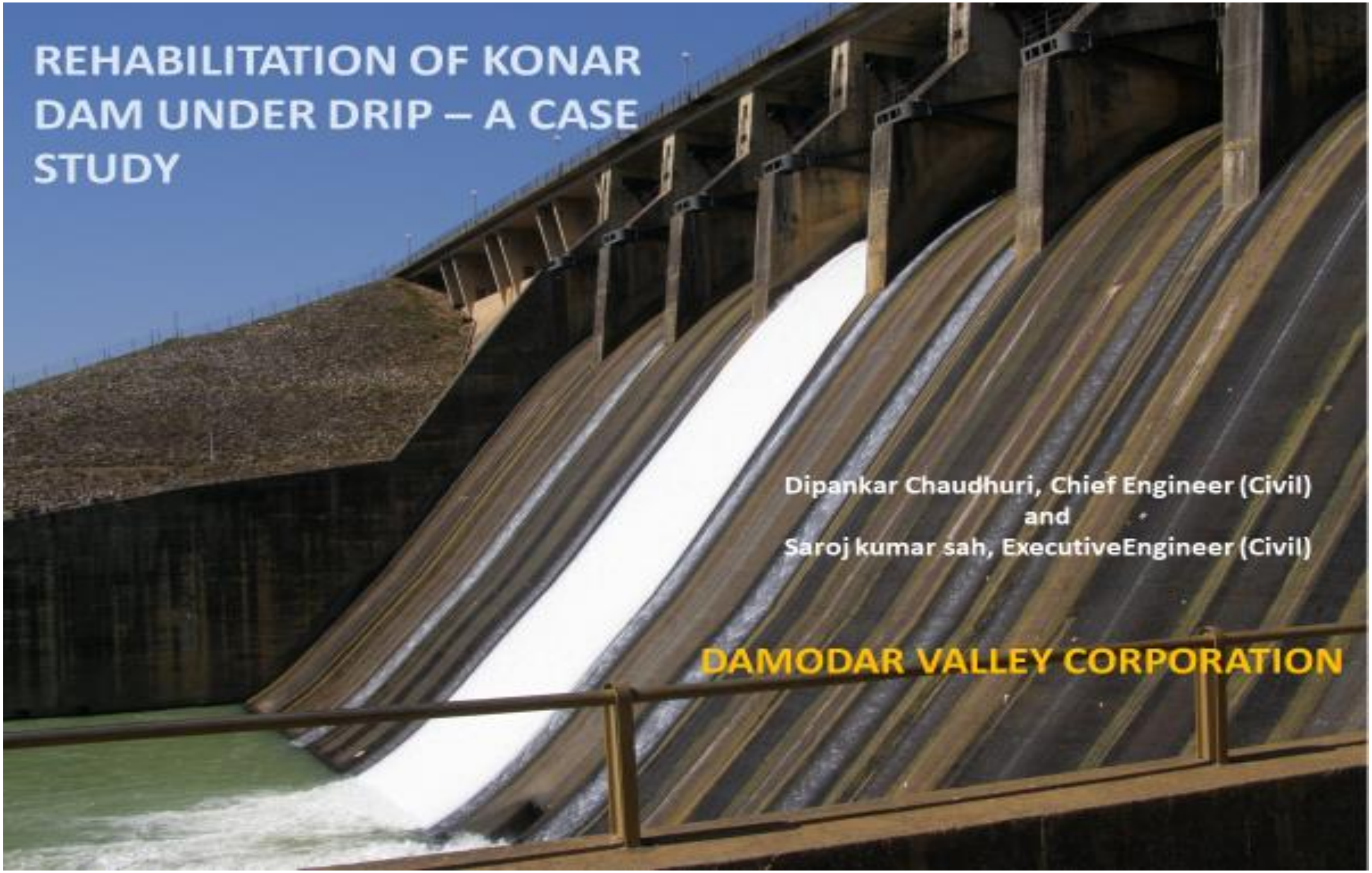
Indian National Committee on Large Dams

INTERNATIONAL DAM SAFETY CONFERENCE

Dam Rehabilitation & Improvement Project

Central Water Commission



10-12 October 2022 at Jaipur, Rajasthan (India)

OVER VIEW

- Problems
- Rehabilitation under DRIP
- Conclusion

MAJOR PROBLEMS

- Partial functioning of the existing hydro mechanical equipment
- Cracks in the dam body and in galleries
- Leakage through penstock
- Rip-rap dislocation at upstream face

Upstream of Konar dam

Down stream training wall of Konar dam

Top of Konar dam

Down stream channel below Konar dam

NATURE AND BEHAVIOUR OF THE CRACKS

- Cracks in the Inspection Gallery were reported first in 1962-63
- Cracks are dominant in inspection gallery w.r.t operating and drainage galleries
- Mostly horizontal and continuous cracks
- At downstream face crack width and numbers are more
- Cracks are more profound at central blocks of the dam
- Depths of the cracks are of considerable amount
- Cracks were observed to be stabilized after 2009

Outer dam body at abutment

Outer dam body at abutment

Down stream face of inspection gallery

Down stream face of inspection gallery

Down stream face of inspection gallery


Down stream face of inspection gallery


DSRP (2013) team in inspection gallery


Leakage through penstock

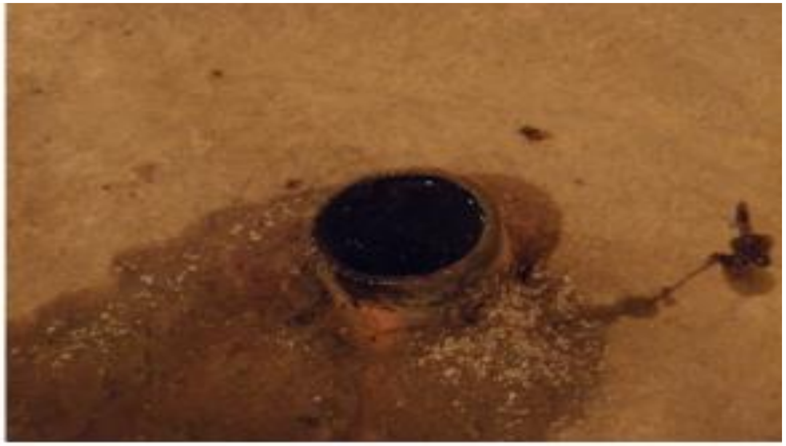

Operating gallery


Operating gallery


Drainage gallery


Drainage gallery

Plumb bob in drainage gallery



Drainage hole in drainage gallery

Crack in drainage gallery

Drainage gallery

INITIATIVES BY DVC UNDER DRIP

- Major works like repairing of cracks, restoring of hydro-mechanical equipment like crest and under-sluice gates, stop log, gantry crane, crest gate inspection walkway, partial upstream rip-rap and downstream slope protection works, automatic gate operation, procurement of diesel generator set, etc. were taken up in DRIP Phase - I with an involvement of Rs.20 Crore which has been completed in the year 2020

- Balance work like dam instrumentation, remaining upstream rip-rap and downstream slope protection works etc. will be considered under DRIP Phase - II estimated cost of which is Rs. 24 crores.

METHODOLOGY OF REPAIRING OF CRACKS UNDER DRIP

- Surface concrete was bare by manual chipping of the plasters and rubbishes were disposed. Care was taken not to damage the core concrete.
- Cutting was made to form U groove (50 mm wide x 50 mm deep) on the concrete surface along the crack. Then surface was cleaned thoroughly and made saturated dry.
- Holes of dia. 25 mm (as required) were drilled in a staggered way up to the depth of 500 mm at a longitudinal spacing of 1.0 m along the line of cracks.
- U groove of 50 mm (W) x 50 mm (D) was filled with high strength cementitious crystalline repair mortar (PENECRETE MORTAR). Product complies EN 1504-3 (2014) Class R4 for structural and non-structural repairs having following property
    - Direct Tensile Bond Strength (2.3 MPa- ACI 503R),
    - Low shrinkage fibre reinforced,
    - Chemical durability (mass loss negligible i.e., 0.22% in 84 days - ASTM C 267),
    - Compressive strength (59.3 MPa @ 28 days - ASTM C 109)
    - Rapid chloride permeability (420 coulombs @ 90 days - ASTM C1202
    - Flexural Strength (8.2 MPa- ASTM C 78 @ 28 days)
    - Splitting Tensile Strength (4.2 MPa - ASTM C 496)
    - Scaling Resistance (no scaling in 50 cycles - ASTM C 672)

METHODOLOGY OF REPAIRING OF CRACKS UNDER DRIP

- Cavities in concrete structure were filled and repaired with cementitious crystalline repair mortar (PENECRETE MORTAR) EN 1504-3 (2014) Class R4 for structural and non-structural repairs.

- Grout mixture consists of micro fine cement of grain size D95 < 20 microns (Alccofine 1108SR) and admixture of crystalline characteristics (PENETRON ADMIX) in a ratio of 5:1 was applied @ 10 Kgs. per grouting hole to treat cracks of width up to 3 mm. Grouting was made injecting water and micro cement in different ratios in different intervals: at first, injecting was started in 3:1 ratio, gradually water vs micro cement ratio was changed to 2:1 and 1:1. The injecting pressure varied between 1 to 1.5 Bar (i.e. 1 to 1.5 kg/cm^2).

- For the crack width more than 3 mm, grouting mix consists of Ordinary Portland Cement (OPC) with admixture having crystalline characteristics (PENETRON ADMIX) and fine silica powder in the ratio of 1:0.5:2. Water and grouting mix ratio along with pressure was maintained as above.

- Durability Enhancement Treatment of Dam Gallery was carried out with a slurry coat of PENETRON CONCENTRATE having properties of suppressing Alkali Aggregate Reaction (AAR) at coverage rate of 1.00 kg/m^2 over the prepared concrete surface to make it water tight. Water was sprayed periodically towards curing for two days after the slurry coat get set.

- Plastering was done on the surface with 20 mm thick cement and sand mortar (1:4) admixed with an admixture (PENETRON ADMIX) having crystalline characteristics {@ 1% by weight of cement and Polyster fibre (Recron 3S of Reliance Industries Limited make) @ 125 gms/bag of cement}. Curing was done for 7 days.

groove cut along the crack in gallery

Gallery after grouting


Leakage through control structure


Leakage stopped in the control structure

Poor condition of the dam top road

Repaired dam top road

Distressed gantry crane

Renovated gantry crane

ISSUES

- Management of huge hydrological data
- Reservoir siltation
- Studies of Reservoir siltation on safety of dam and down stream
- Reservoir life: Structural, Operational, Filling of Dead Storage
- Studies of Reservoir Life and its Review in definite interval
- Watershed Management/Catchment Area Treatment
- Estimation of Reservoir Inflow: Standardized Procedure, Calculation Frequency, Statistical Analysis
- Revision/Review of Reservoir Operation Rule Curve at definite interval
- Watershed wise climate change studies
- Long-term & short-term planning of water availability studies keeping ground water as a reserve potential
- Processing of rainfall data: Standardize procedure for analyzing data and format

CONCLUSION

- Revised PMF will be absorbed safely in the available space with slight encroachment of the free board within the existing flood cushion of this reservoir. However, certainly the rehabilitation works, especially repairing of cracks, under sluices, non-functional hydro mechanical equipment etc. taken up under DRIP will enhance the structural life, also it will take care smooth operation of the reservoir confirming water security and dam safety aspects.


THANKS