SAIL BHILAI STEEL PLANT

STEEL AUTHORITY OF INDIA

BHILAI STEEL PLANT

DALLI MECHANIZED

MINES

TECHNICAL SPECIFICATION

For

Name of the work- Grouting & Re Sectioning work for Hitkasa Tailing Dam strengthening at Dalli Mechanised Mine.

PACKAGE-2

12/5/22

this is header

Contents

071

eel Plant

12/5/22

WAPCOS

this is footer

this is header

teel Plant

Dalli M echanized.Manes B hilai S e Pla

this is footer

1. INTRODUCTION

2. Background Information

2.1. netailed Project Report for ”Condition Assessment of Strengthening of Hitkasa Tailings Dam at Dalli Mechanized Mines under Bhilai Steel Plant” recommended to carry out, inter alia, the following primary works.

2.2. **A Grouting Worker** Curtain Grouting along crestline of Dam 1 to arrest .minor seepage/wetness on downstream slope and Cement/Epoxy grouting for strengthening of Retaining Walls and Waste Weir of the Dam.

2.3. B. **Resectioiilng Works:** Restoration of eroded downsmeam slope of Dam 2 by resectiontng.

3. Input for Tender.

3.1. **Package** 2:.Grouting & Re Sectioning work for Hitka3a Tailing Dam strengthening at Dalll Mechanised Mine.

3.2. Grouting Worlcs.

3.3. Nut Destructive Test (NDT) of the retaining walls and Waste Weir walls of Hitkasa Dam suggested requirement of grouting Jo improve the strength of retaining walls, both upstream and downstream sides of tire crest of Dam 1 and Dam 2.

3.4. Again, .minor seepage in a particular stretch of about 20m was observed on the berm level of the downstream slope of Dam 1. Geotechnical investigation reveals that the raise in height of dam by 3m on the upstream side with rise in .water table has caused the phreatic line to move up. Due to provision of partial horizontal filter instead of a continuous one, .the phreatic line seems to have come close to the downstream slope of Dam 1, particularly near the berm. As the see e is minor in nature and onl kee s a .20m stretch of dam 1 in wet condition, it is reasonable to assume that the phreatic line, even in its raised shape, has not intercepted D/Sslope, but the wetness develops from capillary rise of water above the phreatic line in the partially saturated zone.

4. Proposed Sehetiie for Grouting

4.1. Grout Curtail

4.1.1. It is mandatory to lower the water table in the upstream side for consequent lowering of phreaticline. lt appears. that from operational point of view, Immediate lowering of water table by *lowering* the Full 7ank Level of tailings pond may not be feasible. A grout

curtain has,therefore, been planned to route the phreatic line downwards, as astop gap arrangement.

4.1.2. Grout curtain can be constructed either on the upstream side of dam 1 or along the crest The length of curtain is expected to be about 55m which will sufficiently cover 20m length of wet area near downstream berm *of* Dam 1. Frotri geotechnical Investigation report, it 1s ohserved that the deposited tailings has a perméability of about 10*-4 to 10^{A}-5 cm/sec. Grouting of these failings does not offer enough scope for improving impermeabillty. On the other hand, filling material below road crust for a portion of Dam 1 corresponding to the affected wet area, has presence of boulder in place of clay core. It is apprehended that the presence .of such boulder layers has allowed the phreatic line to come up higher.

4.1.3. *Groudng* of this layer shall improve impermeability thereby guiding the phreatic line to be routed through the existing clay core.

4.1.4. It is therefore, suggested to take up grout curtain along Dam 1 crest. The curtain may be done with the following tentative details:

4.1.5. Top of Grout Curtain: 454.7Sm (Crest level of Dam 1)Terminating level: 4S0m (S00mm into the existing Clay core having top level of 450.5m).

4.1.6. Length of Grouting: 55m.

4.1.7. Number of rows: 2.

4.1.8. Start and End polnt along Dam 1 crest: To be finalized during executiort with shallow confirmatory boPing.

4.1.9. The acceptability .criteria for curtain grouting shall be ensuring stoppage of wetness in the affected zone. Monitoring of grouting effect may be done on pre and pestbasis by installaton of Vibrating Wire Type piezometer at suitablelocations.

4.2. Grouting of Retaining Walls.

4.2.1. Target strength and acceptability criteria.

4.2.2. GFOUtlng of walls shall be carrled out by approved grout mix.

4.2.3. A part of the retaining walls is reinforced. Following extant provision 1of IS Code, a minimum target strength of M 20 (28 days .compressive strength of 20 MPa) is considered as target strength, post.grouting. It will be necessary for .thle agency to ensure a minimtim 20 MPa strength for the retaining walls. Such target shall be ensured through crtishing of concrete cores taken out from grouted retaining walls. The void.left by the cores must be filled with micro-concrete.

5. Grout Mix Planning.

5.1. Cement grouting with additives were recorrim'ended in. the NDT report for strengthening of the retainiñg walls. A grout curtairi comprislng inax 2 rows of grout lines is recommende d as a stop gap arrangement.

5.2. With the above planning in mind and standard practice of grout design, three trial mixes were prepared with additives and tested at laboratory to check flowability, setting time a lid compressive strength.

5.3. Laboratory Test Results of trial mixes.

5.3.1. The data sheets of laboratory testing are attached as **Annexure** 1 for ready reference.

5.3.2. Cement to be used is OPC and shall be ordelred for procurement upon requisition from SAIL Other additives are mentioned as their generic name. Agencies may advised to .use products from reputed manufacturers like Sika, FOSROC, BASF, MYK etc.

6. Discussion

6.1. The estimated coiripressive strengths of the retaining walls are to .the tune of 10 to 1 5 M Pa. It:is targeted that post grouting, the strength shoulfi go at least up to 20 MPa. Pre-grouting strength has already been ascertained .from NDT. Post grouting strefigth shall be ascertained by taking requisite number of cores and crushiiig them at lab oratory.

6.2. It may be noted that each .sample has been tested for three different W/C Ratios of 2 (water): 1 (cement), 1 (water) : 1 (cement) and 0.5 (water) : 1 (cement). Initially leaner grout is injected to ensure absorptlofl of grout and then the rich grouts of low water cement ratio are injected.

6.3. The First set of sample is a mix of cement, polymer and admixture with water cement ratio at 2:1, 1:1 & 0.5:1. But the mix has not given adequate strength though it is.the most econom'ical solution.

6.4. The 2nd.set of sample is a mix of cement, silica sand and admixture with water cement ratio at 2:1, 1:1 & 0.,5:1. The mix has given :adequate.strength but injection through concrete walls may be difficult due to presence of heavier and thicker sand material in the grout mix.

6.5. The Jrd sample which is a mixof microfine cement, polymer and:admixture with.water cement ratio at 2:1, 1:1 & 0:5:1. The rñix has given:adequate *strength* and is most suitable for grouting works.

7. Recommendation.

7.1. It is recommended to consider "Sample No 3" as a grout mix for strengthenlng of concrete walls.

7.2. For uniform spread, a low pressure grouting shall be resorted to during execution.

7.3. Regarding curtain:grouting the depth of the boring will be. about 5.0m (0.5m into the existiñg clay core).

7.4. For curtain .grouting "Sample No 1" may be considered as grout mix.

7.5. The above recommendation shall be.treated as a guideline during procurement phase. The agencies.shall befree.to use theirown Mix Design upon approval from Client or theirauthorized representative. Notwithstanding the stated guidelines, the agencies shall take the responsibility to!fulfil the following acceptance criteria:

7.5.1. fior retaining walls, Core Crushing Strength.shall be not less than 20 MPa.at.28 days (with statistical variations as per IScode).

7.5.2. .Stoppage of wetness at the affected zone post implementation of grout curtain, to be observed overthe dearestmonsoon. Duringexecution,, ptezometer maybeinstalled atsuitablelocations (to be selected by bidders) to monitor the effect of curtain grouting.

7.5.3. A grout mix:is:generally planned on the basis of laboratory tests and the Ingredients and application methodology is firmed up ‹iuring execution. The consumption of grout also varies sub:staatially *from* estimate.as i.t is impossible to predict the quantification of voids in affected structure. The present study is based on tests carried out in a NABL accredited laboratory.

8. Scope of Worh, Methodology and Technical SpeciScatton.

8.1. Introduction:

8.1.1. Hitkasa Tailings Dam has a maximum height of about 35m. The dam, to increase its holding capacity, was raised by 3m in two .stages (2m +1m). During raising of height, the additional materials were retained by constructing Cement Concrete Gravity Retaiqing Wall with intermediate reinforced layer. Total Length of concrete walls are as follows:

8.1.2. For Dam 1: 2 (Pond side i,e U/S and Countryside i,e D/S) x 450m - 900m (approx.).

8.1.3. For Dam 2 U/S: 83.0m (Approx).

8.1.4. For Dam 2 fi/S: 750m (Approx).

8.2. Grouting Works.

8.2.1. Cement and Epoxy GrouGng of Retaining wall and Waste Weir walls.

8.2.2. The concrete walls of Hitkasa Dam are quite old and have eventually becoine weak having cracks and leakages.

8.2.3. The Tailings Pond,has a waste weir for routing the extra water out of .the pond area for reuse. The waste weir has.internal dimension oF 7.Sm (W) x 10m (L):and a depth fif8.5m. The walls and base slab of the waste weir have also become.weak with time.

8.2.4. The Project Authority has got a Non Destructive Test (NDT) carried out for the retaining walls and .the walls of waste weir as well. The NDT report assesses the condition of th.e walls and recommends cement grouting for retaining walls :and epoxy grouting for the walls and base slab of the waste weir.

8.2.5. Grout Curtain to arrest.oiizior seepage.

8.2.6. Again, minor seepage is visible from a stretch of 20m over the Dam .1 berm (downstream slope). It is apprehended that the minor seepage :is due to raised phreatic iine which comes quite close to the downstream sl9pe line resulting in seepage (in the form of wetness in soil) due to capillary action. Geotechnical investigaflon reveals that for a.stretch of dam crest corresponding to the affected area on the downstream slope, .the raising of the core ofthe dam was done with a layer of boulder instead of clayey soil. This might have caused the upstream water level extend (instead *of a* downward curved shape) horizontally through .the boulder layer without getting lowered as is expected for a core made up with clay layer. To address such deficiency, lowerihg of Full reservoir Level is the best sollition Which is not immediately possible due to operational reason.

8.2.7. As a stop gap arrangement, a line of grout curtain is recommended along the dam ctest so as to route the seepage line through the original clay core of dam. Such a step will lower the phreatic line thus staying sufficiently clear of the downstream slope. The wetness, presently seen, is expected to be not visible after anticipated lowering of phreatic line.

8.2.8. Detailed Scope of Works:

8.2.9. Pre bid Visit to site.

8.2.10. The bidders need to visit the site of work and get themselves acquainted with the site condition and discuss the scope of work, salient points of NDT Report and Geotech Report. This is a pre requisite for the bidders to bid for the project.

8.2.11. Based on the recommendation of the NDT report and requirement of grout curtain, the following scope of work for grout ng has been **formulated for the successful tenderer:**

8.2.12. Geo-Physical Investigation.

8.2.13. Geotechnical lnvestigation of Dam 1 has indicated presence of boulder material in the upper portion of dam core section in a stretch matching with the location at downstream berm where wetness and minor seepage is observed. From this observation, it is apprehended that accumulation of pore water and presence of highly saturated zone may be feasible in any stretch along the length of Dam lbetween dam crest and downstream slope.

8.2.14. Geophysical Investigation s, therefore, recommended to locate the saturated zones and probable route of seepage through the embankment of Dam 1.

8.2.15. Electrical Resistivity Imaging (ERI) and Streaming Potential (SP) Study.

8.2.16. The basic premise on which the combination of ERI and SP is recommended is following ERI provides information on presence of water/moisture and thereby saturated zones SP detects flow zones by measuring natural potential due to flow.

8.2.17. - Combinatio n of ERI and SP shall detect the leakage path and validate it. The length of dam 1 embankment along crest is about 450m of which about 200m has a depth between 30 to 40m. Number of electrodes, spacing and roll along length may be planned accordingly. The total number of survey line shall be restrlcted to 4. Streaming Potential (SP).

9. Streaming Potential (SP).

9.1. Streaming Potential shall measure potential due to flow and shall be used for determination of flow path through earthen embankment. Output of SP shall be interpreted alotig with ERI. Anticipated seepage path shall be, drawn on a plan drawing of Dam 1 clearly showing the lines (max 4 in number) along which ERI and SP have been carried .out. The length of groiit curtain (presently envisaged to be SSm, shall be validated from the.interpretation of ERI and SP.

9.2. Design Works.

9.2.1. Though a typ‹ca1 design is furnished as **Annexure** 1 **(Mlx Design Report),** the agencies may accept it.or furñish their own design, get it approved and follow it. In either case,, the delivery of desired result post grouting shall rest on the agency.The scope, of design shall comprise the following:

9.2.2. Preparation of Cement Grout Mix Design for retaining wall and getting:it approved from Engineer In Charge or his authorized representative.

9.2.3. Preparation of Epoxy Grout Mix Design for Waste Weir walls & base slab and getting it approved from Engineer In Charge or his.authorized representative.

9.2.4. Preparation of Design for Grout Curmin and getting it approved from

Engineer In Charge or his authorized representative.

9.2.5. Preparation of scheme and approved design for provision of Vibrating Wire (VW) type piezometer to monitor the effect of grout curtain during execution. (The number and location of ptezometer shall be finalized by agency as per their design).

9.3. Implementation (Grouting and Allied Works).

9.3.1. Setting up laboratory at site with all necessary equipment duly calibrated, tools and tackles to carry out field test and ensure achievement of desired strength.

9.3.2. Installation of VW type ptezometer.

9.3.3. Carrying out Cement Grouting as per approved .design and specification.

9.3.4. Carrying out Epoxy Grouting as per approved design and specification. The .grouting design will have.to be underwater type.

9.3.5. Taking requisite number of concrete cores from the affected walls **post grouting** and get them tested to ensure achievement of desired strength (20 N/mm2 at 281 days).

9.3.6. Filling the core ,spaces with micro cement mortars of 28 days strength at least equal to 20 N/mm2.

9.3.7. Carrying lout drilling works for Curtain Grouting .as per approved methodology and specifcauon.

9.3.8. Carryingoutstagewise (top tobottomapproach ispreferred) groutingandmonitoringits effect on the downstream seepage. .Complete stoppage of seepage shall be treated as indicator of successful completion of Grout,Curtain.

9.3.9. The agency shall carry out a trial patch to ensure efficiency of process and firming up of methodology. The finaJ work may be taken up accordingly.

9.3.10. Client shall provide the successful contractor a copy of the NDT Report, Topographical Survey Report and Geotechnical Investigation Report for their use. However, the successful contractor may, at their own cost, carry out a few confirmatory boreholes to satisfy themself about the in- situ condition.

10. Methodology & Specification.

10.1. Geophysical Investigation (Electrical Resistivity Imaging and

Streaming Potential).

10.1.1. Electrical Resistivity Imaging and Streaming Potential profiles of Dam l to identify areas of water saturation, zones of water accumulation withln the dam cross section,probable seepage.

10.1.2. path by standard procedure using current and potential electrodes for ERI and electrodes, as necessary, for streaming potential as per specification. ERI will involve injecting current into ground and measure the resulting electrical potential distribution. SP shall measure natural potential to determlne seepage how path. The results of ERI shall be presented as vertical section showing internal resistivity distribution within the earthen dam. 2D resistivity imaging using an array of electrodes with speclfied configuration connected by multicore cable to provide a linear depth profile, or psuedo section, of variation in resistivity both along the survey line and depth. The result of SP shall be presented on plan and section and probable seepage path (s) shall be clearly marked on schematic plan of Dam 1.

10.1.3. Electrical Resistivity Imaging (ERI).

10.1.4. 2D Electrical Resistivity Imaging is envisaged which uses an array of electrodes connected by multicore cable to provide a linear depth profile, or pseudo-section, of the variation in resistivity both along a survey line and with depth.

10.1.5. The length of dam 1 embankment along crest is about 450m of which about 200m has a depth between 35 to 40m. Number of electrodes, spacing and roll along length may be planned accordingly. The total number of survey line shall be restricted to 4.

10.1.6. Data Acquisition parameters shall be finalized on the basis of the following:

10.1.7. Length of Spread: About 5 to 6 times the depth (which is 40m max). Roll along shall be planned to cover constant depth over entire length of dam, duty catering to tapered information gathered towards ends of an array.

10.1.8. Electrode Spacing: Spacing of electrodes shall be planned to acquire images of sufficiently high resolution.

10.1.9. Survey Configuration: The configuratio n of current electrodes and potential electrodes shall be such as to be able to record data with both Wenner Array and Wenner- Schlumberger Array.

10.1.10. Streaining Potential (SP):

10.1.11. Streaming Potential shall measure potential due to flow and,shall be used for determination of flow path through earthen embankment. Output of SP shall be interpreted along with ERI.

10.1.12. The configuration of electrodes for Streaming Potental .shall be fixed by the bidder in consultation with the Client. As an output, anticipated seepage path (/s) shall be drawn on a plan drawing .of Dam l clearly showing the lines (max 4 in number) along which ERI and SP have been carried out. The length of grout curtain (presently envisaged to be 55m, shall be validated from the interpretation of ERI and SP.

10.1.13. Earthwork in excavatlon & backfilling of Soil.

10.1.14. Earthwork in **excavation** is **envisaged on** the **upstream side of** Dam1 1 and Dam 2 adjacent to *r*etaining *w* at*ts* (limited only to accessible areas). Such excavation shall be necessary maximum up to a depth of 3.5m from the top of tailings at places where the retaining wall has expansion joints and beside retaining walls if required during thel grquting works. The purpose of such excavation 1s to fix necessary metallic or rubber **strips** from upstream side before filling the expansion joint with flexible filler materials and *for* horizontal grouting in the retaining walls to achieve the required strength ofthe walls. Width of excavation shall be kept minimum to create adequate working space maintaining stable slope .of cut face. No roadside excavation on Dam 1 and Dam 2 crest is generally envisaged for safety of earthen dam. In case, minor excavation is inevitable for wall strengthening, it may be permitted after approval of concern authority.

10.1.15. The area to be excavated shall be properly marked and cleared before starting the works. The depthofexcavation shallbeperiodically checked visuallyto .avoid over-excavation.The,bank of the excavated areashall besloped flat enough to avoid a collapse of the bank into the excavated area. Excavation shall include softsoil and/or murrum with/without pieces of gravels and small boulders. The excavated material .shall be used for backfilling and surplus material, if any, shall be .disposed of at nearby place earmarked for dumping. Excavation can be done by means of mechanical equipment or manually depending upon the site condition without damaging the existing structure. Backfilling will be carrled out in layers with compaction by light compacting equipment.

10.2. Dismantling of Masonry :

10.3. The upstream retaining wall of Dam 1 has a layer of random rubble masonry about S00mm thick and 500mm high constructed over it. This RRM need to .be dismantled and may require restoration after grouting. The masonry wall shall be inspected befor,e the actual .start :of dismantling process and all required safety provisions shall be maintained at site including sign boards, boundary area, etc. The wall masonry then will be demolished with proper tools & equipment withou.t disturbing the

existing retaining wall. The construction debris (wholeorany unusable part) shall be collected and disposed to the designated area.

10.4. Surface Preparation:

10.4.1. Any surface that shall be worked on will be carefully cleaned of dust, dirt, soil and all type of foreign materials by any combination of *opera0ons* including manual chipping machine chipping, Chisel, hammer etc. Finally the surface shall be prepared with high pressure jet cleaninglor wire brushing as required.

10.5. V grnove cutting & Sealing of crachs with epoxy putty:

10.5.1. Identificationofcracks morethan 3 mm and making of Vgroovesi of 50mm wide and 25rrim depth aloiig flawline/crackliiie withOtit damaging the sound concrete. Further, hammering of surface adjacent to Vgroove /crackarea/other si;rfacearea (wi.thout damaging the concrete) to feel the hollow.sound. If hollow sound is felt,. then further chipping has to be carried out until sound concrete ts reached. .Cleaning of concrete surface shall be done with water jet. Surface preparation of crack or flaw zone will have to be done by concrete grinders followed by mechanized emery paper scrubbing to completely expose the cracks and flaws. High jet pressurized water cleaning may be required to be carried out.in .the v•groove/chipped area to clean the dust, dirt and any other foreign material. The very next step is sealing of cracks with epoxy putty including cleaning of V groves, mechanically mixing of two
.component epoxy material, application in crack and filling up to the surface with proper finishing after applying of epoxy bonding agent.

10.5.2. Materials for Sealing of cracks with epoxy putty:

10.5.3. Solvent free epoxy resin based putty (Sika/Fosroc/equivalent material) shall havefollowing general parameters:

10.5.4. High strength Compressive Strength >20 N/m.m^2 after 3 days.

10.5.5. High bond stre ngth»2 N/mm2 after 3 aays.

10.5.6. Epoxybond coat (Sika/Fosroc/Equivalent material) shall have following general parameters:

10.5.7. Compressive Strength »=50 N/mm2 after 7 days.

10.5.8. Tensile Strength '>18-20 N/mm2 after 14 days.

10.6. Cementitious Grouting:

10.6.1. Cement grouting with horizomally drilledholesi.

10.6.2. Horizontal drilling shall be carried out in areas where the affected retaining wall is exposed and accessible. If inevitable, grouting may be done by exposing an area through excavation with prior approval from concern authority. Such drifting may be carried out on the roadside exposed portion of retaining wall (Dam 1 and Dam2), exposed portion of :downstrearii retaining wall of Dam 1 and Dam 2 and inside walls of Waste Weir below steel plate lining.

10.6.3. However, such areas may also be grouted by vertical drilling. Walls in all other zones shall be treated with vertical drilling.

10.6.4. Cement grout with horizontal drilling shall comprise of drilling.of 14-16 mm dia holes up to a depth of 150-200 mm into wall and fixing of 10-12.5mm dia GI/PVC nozzle/packer and sealing the sides using epoxy putty. The drilled holes shall be flushed with high pressure air/water.

10.6.5. All the holes shall be slanting at an angle of 45 degrees or as per site condition. The opening of the hole should be such that the grouting work can be carried out with ease. PVC pipe shall be fixed with the help of cement paste (over the threaded zone) to avoid leakage .at grouting pump end and nozzle end. First, the grouting pump shall be cherked with water for development of pressure. Once the trial operation with water is satisfied, all .the water from pump shall be removed and slurry shall be taken in. A little amount of slurry shall be allowed to go out under pressure to ensure there is no entrapped air in the pump. Then the pump nozzle shall be fitted into the % inch pvc pipe and the valve will be opened. Applying pressure, slurry shall be pumped in slowly till it exerts reverse pressure. lt will be carefully observed if the groutis taking any exit route causing ineffective and wasteful grouGng. The process will continue till further grout is rejecte‘d to get in. Next day nozzle will be removed and the point shall be sealed with cement/epoxy putty. Generally grouting may start with very lean consistency of 2:1 to 1.5:1 water/powder ratio which may then be gradually reduced to 0.8:1 or even below as per mix design and penetration in wall and completed with the ratio 0.5:1. The grouting pressure may be 1-2 kg/sqm.

10.6.6. **Material for Cement grouting as per** mlx design:

10.6.7. Cementitious micro fine crack injection grout (Alccofine or equivalent) having following parameters:

10.6.8. Particle size ass < 20 M,icrons.

10.6.9. Compressive Strength > 35 MPa at 7 Days & >.45 MPa at 28 days.

10.6.10. Potable Water.

10.6.11. Liquid Polymer (Sika/Fosroc/Equivalent material).

10.6.12. Expanding Additives (Sika/Fosroc/Equivalent material).

10.6.13. Cement Grouting with vertically drilled holes:

10.6.14. For unexposed walls not accessthle for horizontal grouting, cementitious ,grouting shall be done thmugh vertically drilled holes. Such drilling shall be carried out in all portions of retaining walls which are .either under water or under tailings and slimes. Maximum depth :of drilling may be considered to be 3m.

10.6.15. Grout holes having dia of 14-16mm drilled to a maximum depth of 3000 mm shall be used .for cement grouting of affected Retaining walls. As the exposed part (about lm from top) of wall shall be grouted through horizontal drilling, remainirig 2m shall be grouped through vertically.

10.6.16. drilled holes. Though grouting from top to bottom or bottom to top .is permissible, it is advisable to execute grouting going from top towards bottom of holes.

10.6.17. GI nozzles of 10-12.5mm dia or PVC nozzle with packer may be.useñ for grouting.

10.6.18. Procedure for grouting grout pump shall be similar to grouting with horizontally drilled holes.

10.6.19. Grout materials shall also be similar to horizontal grouting works as per Grout Mix Design.

10.6.20. Treatmeñt of Expansion joint :

10.6.21. The filler materials of Expansion Joints are now in a poor condition and the expansion joints are acting as points of leaimge. Steps of treatment shall be as follows:

10.6.22. Removal of old filler material from the existing joints!with no or mini.mal damage to.the parent concrete.

10.6.23. Drilling of holes of 50mm dia having different depth max upto 3000 mm depth from dam wall top including, removal ofcore, debris with
c. least possible damageto the adjacent area Surface preparation of joints will be done to make the space (above soil portion or in excavated portion) free from loose/flaky particles, oil, dust etc. The joints surfaces shall be cleaned with wire brush and cleaned by blower/water/air etc. complete. Providing and.filling with best quality of bitumen and quartz sand mix (0.7:0.3) and apply manually along the section through the verticalholes including sealing:of joints by Aluminum plate 3 mm thick and 7.5 mm width on both sides (for road side excavation, prior permission need to be taken) of exposed

portion with fixtures and .M- .seal as per specification including finishing and cleaning etc. complete.

10.6.24. materials for treatment of expansion joints :-

10.6.25. High quality bitumen grade 115/15.

10.6.26. Quartz/silfca sand -Zone III (:grain size 0.3 to 0.6 microns).

10.7. Curtain Grouting :

10.7.1. The objective of curtain grouting is to lower the phreatic line and arrest seepage from an identified affected area. The identified affected area is a stretch of about 20m on the downstream slope of Dam: 1 where wetness is visible at berm level. Grouting shall be done from the crest of dam 1 for a length of about 55m (sufficiently covering the affected length of 20m on the downstream) in one or maximum two rows. The depth :of curtain shall be tentatively 5m with battom of curtain driven 500mm into the existing clay core.

10.7.2. The actual grouting!dimension, spacing of drill holes, number of rows and final depth of curtain shall be firmed up on the basis of detailed.design to be done and got approved beforehand and necessary modification during execution.

10.7.3. As an option, the agencies are encouraged to install vibrating wire type piezometer to monitor effect of grout curtain pre and post grouting basis. Stoppage of seepage from the affected area for a substantial period of tme shall indicate successful completiQn Of curtain grouting. At the **same time, curtain grouGng in the affected zone must not give rise to seepage from any** nearby new area.

10.7.4. Vertical drilling up to diameter of 7S mm shall be done by rotating drilling system under high pressure to the desired depth. The next step is to place the equipment .over the drill hole to conduct the injection process. The equipment consists of a jet grouting string of required diameter. At the end of this string, it possesses a nozzle in order to have an injection at a higher velocity. At the start, the xtriñg is raised and rotated siowly to seal the whiile
.column surface with soil and the fluid system that has to b,e injected. After that mairi jetting starts and in the process the fluid is injected (through a rotary motion) and the string is raised and spoil is discharge out.

10.7.5. Curtain Grouting shall preferably be done from top to bottom at segmental depth of about 3m. Subsequent segments shall be drilled through the first segment and continuously monitoring its effect on the downstream seepage.

10.7.6. Materials for Curtain grouting :

10.7.7. 43 Grade OPC cement slurry with additives .OR Micro fine cement

slurry girth additives as per approved mix design.

10.8. Filling of Honeycomb/ cavity with Epoxy material :

10.8.1. For repairing *of cavises* within existing concrete, epoxy material *shzI1* be, used to ensure bond between old and new concrete. Surface prepa:ration of affected area shall involve cleaning of cavities and honeycomb from dirt, dust, oil, grease Cleaning: shall be done with tiigh pressure jet and wee brush. Two component epoxy petty shall then be mechanically mixed and applied on the prepared surface area.

10.9. Specifications of material properties for filling ofhoneycoinb/cavity :-

10.10. Two component,.solvent free epoxy material (Sika/Fosroc/equivalent material).

10.11. .High strength Compressive Strength >20 N/mm2 fur 3 dayi.

10.11.1. c) High bond strength>2 N/mm2 in 3 days.

10.12. Drilling Holes and fixing of nozzles:

10.12.1. Forgrou,tlng atshallow depth, drilling of holes having 100-125 mm depth, 14-16 mm dia shall be done at a spacing suitable for the work to be carried out. In these holes, 8-10 mm dia Gl/PVC nozzle/packer .shall be fixed:and the sides shall be sealéd with epoxy matefial. The drilled holes shall be flushed with High pressure air. AU the holes shall be drilled at *an* angle of 4S degrees or as per site condition. The opening ofthe hole should be such that the grouting work can be carried out with lease.

10.13. Grouting with underwater Epoxy Grout:

10.13.1. Under water epoxy grouting may be needed for treating the base and walls ofthe waste weir. The waste weir pit receives water from pond 24x7 except 1 day per fortnight (generally Tuesday) when maintenance shutdown of classified takes place, Such maintenance shutdown notwithstanding the waste weir area remains damp all the .time. Grouting with epoxy grouting chemical of low viscosity is, therefore, recommended for grouting the walls and its base.

10.13.2. The process of drilling and fixing nozzles shall be same as discussed above. The chemicals shall be mixed as per the specification using mechanical stirrer only and.then pumped through nozzle using!injection pump. Injection of the grout material through the noziles shall be done with a pressure of 2-4 kg/sqm up to refusal. After grouting the nozzles packers should be removed and injection holes are to be sealed with epoxy putty.

10.13.3. Specia*ation •£material properties fur U.nderwater Epoxy Grnut:

10.13.4. Tw*o* component, solvent free epoxy material (Sika/ fiosroe /equivalent material).

10.13.5. High strength Compressive Strength >45 N/mm^2 for 7!days.

10.13.6. High bond strength» S N/mm2 in 3 days.

10.14. Wrapping with composite material **(OPTIONAL):**

10.14.1. The exposed portion of retaining wall shall be treated with Fibre Reinforced Polymer (FRP) wrapping fabric. The composite reinforcem ent fabric shall essentially *be* utiidirectionai fabric comprising of high strength continuous .fibres oriented orthogonal to each other. The Rim reinforcement fabric.shall be woven and bounded such that there shall be no fraying of the main and secondary direction fibres upon sizing, .saturation .and handling prior to and during the wrapping operation. The detailed, technic,al specification for material, workmanship and testing shall be in accordance with ACI 440- 2R.08, MCI 440- OR, ASTM D-.3039 and other relevant codes. Wrapping the fibre sheetlto structural element shall be done at desired orientation usilsg tamping roller to avoid any air voids etc. FOr repeating process, the same procedure shall be followed for mulfiple layers with an interval of 8 hrs.

10.14.2. Specifications of material properties for Composite wrapping:-

10.14.3. Ultimate tensile strength in longitudinal direction of the fibre > 3000 MPa

10.14.4. Modulus of Elasticity: - 2 20-240 G Pa.

10.14.5. Elongation at 8reak: » 1.2%

10.14.6. Thickness: > 0.250 mm

10.14.7. Density- (1.5-1.6 g/cu cm)

10.14.8. ***Resins—*** A wide range of polymeric resins, including primers, putty fillers, saturator and adhesives are used with FRP systems. Commonly used resin types, including epoxy, vinyl esters and polyesters have been formulated for use in a wide range of environmental conditions. In FRP system contractor will use resins that have: Compatibility with and adhesion to the concrete substrate;

10.14.9. Compatibility with and adhesion to the FRP composite system;

10.14.10. Resistance to environmental effects, including but not limited to moisture, salt water, temperature extremes, and chemicals normally associated with exposed concrete.

10.14.11. Fill rig ability;

10.14.12. Workability;

10.14.13. Pot life consistent with the application; and

10.14.14. Compatlbility with and adhesion to the reinforcing fibre; and

10.14.15. Development of appropriate mechanical properties for the FRP composite.

10.14.16. Primer—Primer is used to penetrate thesurface ofthe concrete, providing an improved adhesive bond for the saturating resin or adhesive. Saturating resin—saturating resin is used to impregnate the reinforcing fibers, fix them in place, and provide a shear load path to effectively transfer load between fibers.

10.14.17. The saturating resin also serves as the adhesive for wet layup systems, providing a shear load path between the previously primed concrete substrate and the FRP system. Material shall be purchased from renowned manufacturer. Contractor shall submit test certificate of materials to engineer-in-charge from Government lab / public sector lab / renowned government approved private lab before its use. Physical properties and material specification of primer and saturating resin shall be in accordance with relevant Indian or any other standard code or specification.

10.14.18. The FRP composite system shall include an anchoring system for effective load transfer or in cases of complete confinement of structure. The anchoring system shall be of the same composite material. The size of anchor insert length and splay diameter shall stick to manufacturer's specification and as per the requirement of structural consultant. The efficacy of the anchoring system shall be substantiated by test report data.

10.14.19. ***Wrapping.•*** - Wrapping the flber sheet to structural element at desired orientation and when the. underlying saturant has WFT of 25.0 microns using tamping roller to avoid any air voids etc, repeat the same procedure for mulfiple layer as per requirement with the interval of 8 hrs. Applying second coat of saturant after 30 minutes from application of Carbon fibre.

10.14.20. *Sand pasting aIN plasteri*ng:- After .12 hours curing rectify air voiiis if any paste the river sand on it to.makesurface rough to takefurther and plastering12 mm thickover thesurface after complete curing using cement: Sand mortar ratio 1:S. to give uniform finish.

10.14.21. Materials for Composite Wrapping :-

10.14.22. Carbon fibre sheet (Sika/Fosroc/Equivalent Material.

10.14.23. Saturant (Sika/FOSl'0c/Equivalent MateriaJ).

10.14.24. Primer (Sika/Fosroc/Equivalent Material).

10.14.25. Epoxy putty (Sika/Fosroc/Equivalent Material).

End of Clauses

Resectioning Works

7. Resectioning of Downstream Slope of Dam 2

A substantial length of the downstream slope of Dam 2 has been badly eroded. Slope Stability Analysis of Dam 2 has recommended requisite shape to which the eroded slope has to be made up thereby resectioning the downstream slope. Alongwith resectioning, the dam section as originally contemplated lncluding horizontal filter and rock toe shall have to be relaid.

For quantity estimation, the design section of Dam 2 (D/S slope and crest) was superimposed over the present eroded profile. The quantity (with necessary adjustments) of cutting and filling have thus been determined on Auto CAD platform.

8. Methodology and Specification of material

10.1 Earth fill Specification

The materials used in Dam embankment shall be sand, moorum, gravel and rock pieces. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment.

The following types of material shall be considered unsuitable for embankment:

a) Materials from swamps, marsh and bogs
b) Materials susceptible to spontaneous combustion
c) Clayey soil having liquid limit exceeding 50 and plasticity index exceeding 2S
d) Materials with salts resulting in leaching

The suggested engineering properties of the filling material to be used shall be as follows:

Borrow material shall have Maximum laboratory dry unit

weight when tested as per IS:2720 (Part 8), kN/ cu.m	more than 16
Undrained Coheslon	15 to 2S kPa
Coefficient of internal Friction , phi,	30•

10.2 Specification for Rocktoe and Horizontal Filter

10.2.1, Rocktoe material shall have Dso = I50mm. Strength of rock pieces / boulder shall be not less than 400kg/cm'.

10.2.2. Sandy material shall be used as h orizontal filter and filter layer between rocktoe and fi11 of earth. Inverted filter shall comprise of sandy gravely material having Dso = 0.8 mm , 7.0 mm and 40 mm respectively.

10:3 Compaction Requirements for Embankment.

Relative compaction aa percentage of maximum laboratory dry density as per 18:2720 (Part 8) shall not be less than 95%

A graph of'dry density plotted against moisture content from which maximum dry ‹density and optimum moisture content shall be determined.

The fill mate.rial shall be spread in layers of uniform thickness in the entire width. The compacted thickness, of each layer shall not be more than 300 mm when vibratory roller/vibratory soil compactor is used and not more than 200 mm when B0-100 kN static roller is used.

MoiSture content of .the material shall be, checked at the site of placement prior to commencement of compaction; if.found to he out of agreed limits,.the sameshall be made good. Where wateris required to'be added in such constriictions, watershall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate offlow to variable widths of surface b.utwithout any flooding.

9. Time of Completion: 18 rrionths from date or award letter

10. Defect Li:ability Period: 12 months after project completioiidate.