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<div> <div>11</div> <div><b><u>DRILLING</u></b></div> </div> <div> <div>11.1</div> <div><b><u>SCOPE OF WORK</u></b></div> </div> <div> <div>i)</div> <div>The work under this Chapter includes all labour, materials, equipment, operations and performance of all works required for drilling at locations shown on the Drawings or as directed by the Project Manager.</div> </div> <div> <div>ii)</div> <div>Drilling shall be required to be carried out in overburden, rock or concrete and at any location to depths as shown in the drawings, or as required at site.</div> </div> <div> <div>iii)</div> <div>The drill holes could be vertical, inclined or horizontal as per requirement. The size of the drill holes may also vary as shown in the drawings or as directed by the Project Manager.</div> </div> <div> <div>iv)</div> <div>Drilling from the surface shall include the following:</div> <div> <div>a)</div> <div>Drilling of exploratory holes,</div> </div> <div> <div>b)</div> <div>Drilling for consolidation and curtain grouting,</div> </div> <div> <div>c)</div> <div>Drilling of check holes to determine effectiveness of grouting,</div> </div> <div> <div>d)</div> <div>Drilling for installation of instruments.</div> </div> </div> <div> <div>v)</div> <div>Drilling from the underground shall include the following:</div> <div> <div>a)</div> <div>Drilling of exploratory holes,</div> </div> <div> <div>b)</div> <div>Drilling for consolidation and curtain grouting,</div> </div> <div> <div>c)</div> <div>Drilling of check holes to determine effectiveness of grouting,</div> </div> <div> <div>d)</div> <div>Drilling of holes in the lining for contact grouting between the lining and the rock/rock support,</div> </div> <div> <div>e)</div> <div>Drilling for consolidation grouting of zones of sheared and fractured nature or as shown in the drawings or as instructed by the Project Manager,</div> </div> <div> <div>f)</div> <div>Drilling for installation of instruments.</div> </div> </div> <div> <div>vi)</div> <div>Any of the above drillings may serve as multiple purpose or act as drainage, pressure relief or weep hole, and may serve for water pressure testing as specified in Chapter “Grouting”.</div> </div>		
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<p>vii) The extent of the proposed drilling programme is tentative. The Project Manager reserves the right to increase or decrease any part of the drilling programme at his sole discretion.</p> <p><b>11.2 SUBMITTALS</b></p> <p>i) 30 days prior to the intended commencement of drilling in any working area, the Contractor shall prepare and submit to the Project Manager a drilling plan.</p> <p>ii) The Contractor shall submit drilling logs and other pertinent information to the Project Manager on completion of drilling work of any hole or as requested by the Project Manager.</p> <p>iii) For drillings with core recovery, the Contractor shall keep accurate records and submit to the Project Manager within 48 hours of completion of a drilling a report containing the following information. These records shall be always available at site for inspection of the Project Manager or his authorised representative.</p> <ul style="list-style-type: none"> <li>a) Depth, diameter of hole,</li> <li>b) Date of drilling indicating detailed drilling time,</li> <li>c) Location and nature of the hole drilled including its elevation, co-ordinates etc.,</li> <li>d) Results of water pressure testing,</li> <li>e) Elevation of the ground water encountered during drilling, date and time of measurement,</li> <li>f) Results of any special tests as instructed by the Project Manager,</li> <li>g) A record of the driller's observations on progress of drilling, rate of penetration, speed and uniformity of rotation of bit, action of the drill rig such as jerky, smooth, rough, steady, etc.,</li> <li>h) Length of each core run and the length and percentage of the core recovered and location and cause of core losses,</li> </ul>		
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<div> <div>IS: 6926      Code of practice for diamond core drilling.</div> <div>IS: 9026      Rope threaded percussion long hole drilling equipment.</div> </div> <p><b>11.5      <u>PLANT AND EQUIPMENT</u></b></p> <div> <div>i)      All drilling equipments shall be of a type and capacity and in a mechanical condition approved by the Project Manager and suitable for performing the work in an efficient and workman like manner.</div> <div>ii)      The Contractor shall keep at the site an ample supply of different types and sizes of drilling bits to allow optimal drilling in the different materials to be encountered in the course of work, and sufficient rods and casings of various diameters to allow proper telescoping and to ensure the stability of drill holes.</div> <div>iii)      Standard drilling equipment of the rotary or percussion type shall be used to perform the drilling as specified herein and as required by Project Manager. Standard diamond drilling equipment shall be used to perform rotary drillings and the drilling of exploratory holes. Percussion drilling equipment shall be equipped with a water swivel for continuous flushing of the holes during drilling.</div> <div>iv)      Drillings may be carried out at any angle, upward or downward. The following maximum depths are assumed: <div> <div>a)      Exploratory holes up to 40 m,</div> <div>b)      Dam grout curtain up to 20 m,</div> <div>c)      Consolidation and sealing grouting holes to a maximum depth of 15 m,</div> <div>d)      Contact grouting to a maximum depth of 5 m.</div> </div> </div> <div>v)      Exploratory drillings will in general not exceed the depth indicated above. The rigs shall, however, be capable of drilling holes of 75 mm diameter (NX size) to a depth of 150 m.</div> <div>vi)      The drilling units shall be mobile and of size suitable to the dimensions of the tunnels and galleries.</div> </div>		
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<div> <div>vii)</div> <div>The Contractor shall provide measuring equipment for checking the actual inclination and alignment of drill holes.</div> </div> <div> <div>viii)</div> <div>The Contractor shall provide sufficient pump capacity and storage to ensure a continuous supply of water to all drilling operations at all times at each drilling location. Minimum water pressure in the supply lines shall be 0.70 N/mm<sup>2</sup> (<math>\approx</math> 7.14 kg/cm<sup>2</sup>). Sufficient compressed air shall be supplied by the Contractor to perform the work with all equipment using compressed air operating at full capacity, the minimum delivery pressure in the air supply lines shall be 1.50 N/mm<sup>2</sup> at all times.</div> </div> <div> <div>ix)</div> <div>Drill casing where required shall be of high quality steel, plain or perforated as directed or approved by the Project Manager.</div> </div> <div> <div>x)</div> <div>Contractor shall provide securely nailed wooden core boxes, acceptable to Project Manager. Designated marks, hole numbers and elevations shall be placed on the end of the boxes and along the line of core. The covers shall be fastened securely to the core boxes, and each box shall have independent locks.</div> </div> <div> <div>xi)</div> <div>In order to ensure efficient and satisfactory performance, Contractor shall employ competent and experienced drilling supervisors who shall execute the directives of the Project Manager and supervise the work to be done.</div> </div> <div> <div>11.6</div> <div><b><u>EXECUTION OF DRILLING WORKS</u></b></div> </div> <div> <div>11.6.1</div> <div><b><u>GENERAL</u></b></div> </div> <div> <div>i)</div> <div>The number of holes to be drilled, their location, sequence, orientation, inclination, diameter and the depths shall be as shown on the drawings, or as directed by the Project Manager.</div> </div> <div> <div>ii)</div> <div>The use of rod dope, grease or other lubricants on drill rods shall not be permitted. No drilling water additives of any kind shall be used without the written permission of Project Manager.</div> </div> <div> <div>iii)</div> <div>All holes shall be established to within 250 mm of the specified location. All orientation shall be within 3 degree of the orientation specified. If for any</div> </div>		
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reason the drill hole deviates in inclination or orientation in such a way that it does not satisfy the purpose for which it was intended, the Contractor shall correct the deviation or shall drill another hole to the satisfaction of Project Manager.

- iv) Whenever the drill water is lost or artesian flow is encountered drilling operations may be stopped by Project Manager who may require the hole to be grouted before drilling operations are resumed. The Contractor is required to record the location, the flow and pressure of any artesian conditions encountered in any drill hole.
- v) Whenever required for stage grouting, the Contractor shall drill the hole in successive stages from the collar of the hole downward. Staged drilling and grouting shall consist of: drilling the hole to a limited depth; washing out the hole; seating the packer just above the section to be grouted; grouting the section and allowing the grout to set; drilling the hole through the hardened grout to an additional depth; and thus successively drilling and grouting until the required depth of hole is completely drilled and grouted.
- vi) Holes drilled in soft and fractured rock shall, with the approval of the Project Manager be cased with a plain or perforated steel pipe. Where practicable such casings shall be removed later. Casing shall only remain permanently in place with the further approval of the Project Manager.
- vii) On completion of drilling and washing of any grout or pressure relief holes drilled through the floor of the galleries, the Contractor shall immediately cap the holes with proper removable plugs (wooden or plastic) and shall protect them from entry of dirt or other foreign material. Any grout or pressure relief hole that gets obstructed prior to grouting or installation of elbow shall be cleaned out or the Contractor shall drill another hole.
- viii) Grout or pressure relief holes shall not be drilled within 12 m of another hole which is being grouted or which has been grouted within the previous 24 hours unless instructed by the Project Manager.

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#### 11.6.2 DRILLING METHODS

- i) Most of the holes for consolidation, curtain or contact grouting and pressure relief will be drilled with drill of the percussion type which shall be equipped for constant water flushing at the far end of the drilling rod.
- ii) Holes for grouting not exceeding 30 meters in depth shall be drilled using percussion type drills, excepting that where holes satisfactory for grouting cannot be drilled by percussive methods, the Project Manager may direct the use of rotary drilling methods.
- iii) Holes in excess of 30 m in depth shall normally be drilled by rotary drilling methods using coring bits. Core recovery will usually not be required, except if directed by the Project Manager.
- iv) Modifications to drilling techniques may be required as the knowledge and experience of rock and foundation conditions are gained. The Contractor will be required to alter his operations properly to meet such modifications as per the instructions of the Project Manager.

#### 11.6.3 DRILLING OF HOLES FOR CONSOLIDATION AND CURTAIN GROUTING


- i) Holes for consolidation and curtain grouting shall have a minimum diameter of 38 - 48 mm.
- ii) Holes drilled in soft and fractured rock shall, with the approval of the Project Manager be cased with a perforated steel pipe. Where practicable such casings shall be removed later. Casing shall only remain permanently in place with the further approval of the Project Manager.

#### 11.6.4 PILOT HOLES

- i) Pilot holes shall be drilled ahead of the tunnel excavation, wherever required by the Project Manager, to determine in advance, the nature of the material to be excavated and the presence of any water and gases.
- ii) The drilling of pilot holes in drill and blast methods, shall be included in the normal pattern of drilling the blast holes. The diameter of each hole shall not

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be less than 38 mm. The length of pilot hole shall be decided by the Project Manager.

#### 11.6.5 EXPLORATORY DRILLING

- i) Exploratory drill holes, from which cores shall be obtained, may be required to determine the condition of the rock before grouting or after grouting, to test the effectiveness of the grouting operations. Logging of cores will be done in presence of the Project Manager.
- ii) The Contractor shall use double and triple tube core barrels.
- iii) Contractor shall place the cores in the boxes in correct sequence, segregated accurately by labelled wooden blocks according to the measured distances in the holes. No box shall contain core from more than one hole. Designated marks, hole numbers and elevations shall be placed on the end of the boxes and along the line of core. The core boxes shall be delivered to site laboratory as per direction of Project Manager.


#### 11.6.6 DRILLING OF HOLES FOR DRAINING OF ROCK


- i) The Contractor shall drill holes around the periphery of the excavation for draining the surrounding rock. The minimum diameter of holes shall be at least 38 mm or as shown on the drawings or as directed by the Project Manager.
- ii) When so directed by the Project Manager, these holes shall be used for consolidation grouting of the surrounding rock to check the leakage of water.
- iii) The holes drilled in the roof of the tunnel arch shall be fitted with slotted PVC or galvanized pipes extending from the ceiling of the arch to the vertical walls of the tunnel or as directed by the Project Manager. Galvanised iron pipes with manifolds shall later be covered by shotcrete.

#### 11.6.7 DRILLING THROUGH CONCRETE

- i) Grout holes shall be drilled either directly into the rock or through the concrete lining and then into rock or as directed by the Project Manager.

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<div> <div>ii)</div> <div>The holes shall be drilled in a direction normal to the surface of the underground excavation or concrete lining as the case may be. In cases where seams, if any, in the rock have to be intersected, the holes shall be drilled at inclinations as directed by the Project Manager.</div> </div> <div> <div>iii)</div> <div>While drilling the holes, utmost care shall be taken to ensure that the reinforcement or structural ribs, if any, in the concrete lining shall not be cut through. The position of steel ribs shall be recorded and marked on the finished concrete lining. If the reinforcement or steel ribs are encountered during drilling of any hole in concrete, drilling shall be discontinued immediately and a new hole shall be drilled nearby. The holes so abandoned shall be backfilled with concrete as directed by the Project Manager and the surface of concrete shall be repaired.</div> </div> <div> <div>iv)</div> <div>No hole shall be drilled through concrete before 5 days after the placement of the concrete.</div> </div> <div> <div>11.6.8</div> <div><u>PROTECTION AND CLEANING OF DRILL HOLES</u></div> </div> <div> <div>i)</div> <div>All drill holes shall be thoroughly washed and cleaned by allowing drilling water to run until the return from the hole is reasonably clean as explained in IS: 6066 - 1994.</div> </div> <div> <div>ii)</div> <div>During drilling, washing and pressure testing operations, the Contractor shall keep concrete and rock surfaces free and clean of oil, grease, drill cuttings, grout, cement, excess of water or any kind of waste. At all times during the progress of the work covered by this Chapter the Contractor shall protect all open drill holes from becoming plugged or filled with oil, grease, drill cuttings, grout or waste. The Contractor shall clean up; and remove all waste upon completion of the work in each area before he vacates that area.</div> </div> <div> <div>iii)</div> <div>Each hole shall be protected from getting clogged or obstructed by a grout connection pipe fixed suitably into the holes and the holes shall be suitably capped or otherwise protected until these are grouted. Any hole that</div> </div>		
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becomes obstructed shall be cleaned out in a satisfactory manner or re-drilled and cleaned at the Contractor's cost.


## 11.7 **MEASUREMENT AND PAYMENT**

### 11.7.1 **GENERAL**

- i) The estimates of the quantities for drilling given in the Bill of Quantities are to be considered as indicative only and serving the Contractor to prepare his Tender and not as an accurate indication of the quantity of the work.
- ii) The quantities for each of the pay items will be varied to suit the conditions disclosed in the course of the work, and the Contractor shall not be entitled to any extra payment over and above the Unit Prices by reason of changes of the amount, type and length of holes to be drilled or due to any other reason.
- iii) Measurement for payment and payment will be made for drilling holes:
  - a) By different drilling method i.e. by rotary and percussion methods,
  - b) With and without core recovery,
  - c) Of different length:
    - not exceeding 10 m
    - exceeding 10 m but not exceeding 30 m
    - exceeding 30 m but not exceeding 50 m
    - exceeding 50 m
  - d) Of different diameters
    - 38 mm
    - 48 mm
    - 76 mm
    - 99 mm
  - e) No distinction shall be made between holes drilled for different purposes, except on whether or not core recovery is required.
- iv) No separate measurement and payment will be made for setting up of drilling equipments.

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<div> <div>v)</div> <div>Measurement for payment will be of the length of the hole actually drilled. The unit price shall apply irrespective of the location, inclination (including overhead) of the hole to be drilled.</div> </div> <div> <div>vi)</div> <div>The unit prices shall include for all labour, equipment and materials required for the execution of the work.</div> </div> <div> <div>vii)</div> <div>Holes, which cannot be used because of cave-ins, lost drill stems or packers, will not be measured for payment.</div> </div> <div> <div>viii)</div> <div>Where drilling is required after placing of the structural concrete lining, measurement of the length of hole drilled shall include the theoretical thickness of the lining irrespective of whether the hole was actually drilled through the lining or formed by other means.</div> </div> <div> <div>ix)</div> <div>Additional payment will be made for drilling with core recovery. The unit price shall include supply of core boxes, handling of cores, transport and reporting and additional payment shall be made on the length in linear meters of hole so drilled.</div> </div> <div> <div>11.7.2</div> <div><u>DRILLING FOR STAGE GROUTING</u></div> </div> <div> <div>i)</div> <div>When drilling of the hole is carried out successively for multiple-stage grouting, the measurement for payment will only be of the total length of the hole drilled actually in the rock or concrete. Any re-drilling required because of the Contractor's failure to clean the grout out of the hole before it has set, shall be performed at the expense of the Contractor.</div> </div> <div> <div>ii)</div> <div>Measurement of any required re-drilling where the grout has been allowed to set at the direction of the Project Manager will be of the actual length of re-drilled hole. Payment for this length in linear meters will be made in the form of an additional payment over and above that made for the original drilling at the rate of 50% of the appropriate Unit Price.</div> </div>		
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#### 11.7.3 INSTALLATION OF PIPES

- i) Measurement and payment will be made for supply and installation of PVC pipes (plain or slotted) and steel pipes (plain or perforated) along with required fittings or accessories.
- ii) Measurement of supply and installation of plain or slotted PVC pipes (plain or slotted) and steel pipes (plain or perforated) will be the length of pipe actually installed in positions as directed by the Project Manager. Payment will be made at the Unit Price per linear meter pipe entered in the Bill of Quantities, which shall include the entire cost of labour, equipment and materials for supply and installation of the pipes along with any required fittings or accessories.

#### 11.7.4 EXCLUSIONS

- i) All costs for drilling the holes for rock bolts, grouted anchor bar and pre-stressed anchors are excluded from this Chapter and will be measured and paid for in accordance with provisions of Chapter "Rock Support".
- ii) All costs for drilling in association with drilling and blasting for underground excavations will be measured and paid for in accordance with provisions of Chapter "Underground Excavation".
- iii) No extra measurement for payment or payment will be made for the following:
  - a) Drilling through steel ribs, steel lagging, reinforcing steel or steel lining,
  - b) Installation and removal of grout stub pipes,
  - c) Reaming or re-drilling any holes through the concrete lining for the purpose of placing, and for supplying and placing, the dry-pack mortar,
  - d) Holes which have been blocked and cannot be used because of cave-ins, lost drill rods or packers, or striking other obstructions

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<div> <p>(e.g. reinforcement bars), and drilling the new holes to replace them.</p> <p>iv) Re-drilling required because of the Contractor's failure to clear out a hole before the grout has set shall be performed by the Contractor at his own expense.</p> <p>End of Chapter</p> </div> <div data-bbox="1398 2033 1495 2123"> ISSUE P0 </div>		