14. STRUCTURAL IMPACT ASSESSMENT, SETTLEMENT CONTROL AND MONITORING

14.1 General

14.1.1 The Contractor is solely responsible for ensuring that his design and construction does not cause damage to surrounding infrastructure, buildings, and complies with all statutory obligations and requirements of the Authority and other authorities, such as LTA CDC, BCA Circulars, etc, whichever is more stringent.

14.1.2 The Contractor shall indemnify the Authority for any costs arising from settlement or ground movements caused by the Works.

14.1.3 The Contractor shall view available as-built structural and foundation drawings at the Authority's office. The Contractor shall note that the reports and as-built drawings may not contain building/foundation information for every building/structure that is likely to be affected by the Works. In the event that the as-built structural and foundation drawings are incomplete or not available, the Contractor shall be responsible for seeking and ascertaining the relevant information including the purchase of as-built drawings necessary for his design and impact assessment with all such costs deemed included in the Contract Price.

14.2 Buildings/Structures to be Assessed

14.2.1 All buildings and structures likely to be affected by the Works shall be assessed based on the LTA Civil Design Criteria (CDC) and BCA requirements for the likelihood of damage. Based on the Contractor's detailed construction methodology and predicted ground movements, he shall determine the zone of influence of the Works. The minimum zone of influence for the Works is specified in **Appendix E** of the Particular Specification. The Contractor shall carry out pre-condition surveys of the buildings or structures for the purpose of building impact assessment study.

- Condition of structure - detailed description together with photographs including particulars such as the type or quality of finishes in the areas likely to be affected by Works, existing defects with detailed measurements, observation of cracks, verticality, history of previous repair, location and type of strengthening measures adopted;

- Location plan to identify areas described; and

- Proposed types and locations of instrumentation and monitoring.

14.3.15.3 The Contractor shall submit a proposed format for the condition surveys for the acceptance of the Engineer before finalising his reports. The Contractor shall submit the reports duly signed by the PE within four (4) weeks of completing the surveys.

14.3.15.4 The Contractor shall propose appropriate monitoring systems for structures based on the findings of the surveys.

14.3.15.5 Photographs taken by the Contractor and/or his PE for all condition surveys shall be as follows:-

- Each photograph shall clearly show all the necessary details intended to be shown and as described in the report;

- Details of cracks/defects shown in the photographs shall contain a graduated scale;

- For pre-construction condition survey, matt colour prints (dated and size 4R) shall be presented, annotated and submitted in bound volumes together with negatives/soft copies; and

- For post-construction condition survey, digital photographs (high quality, minimum seven (7) mega-pixel, size 4R and dated) shall be presented, annotated and submitted in bound volumes with negatives/soft copies.

14.3.15.5A <u>The Contractor shall note the strict requirements for taking photographs at sensitive high security areas and must allow sufficient time and resources to get sufficient permissions and equipment in order to comply with security requirements of those premises.</u>

14.3.15.6 A sketch plan shall be included in each individual structure report to show the location and orientation of each photograph. In the event that the photographs are of a quality unacceptable to the Authority, they shall be retaken at the Contractor's own cost.

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- The design head to be maintained during the normal operation of the recharge well shall be at least 2m of water head. Pressure head shall be adjusted if the performance of the well does not meet the design requirement. The design injection pressure shall ensure that the wells and surrounding ground remain stable and do not heave at surface.

14.7.10.4 Installation and Testing of Recharge wells

- The well system shall be arranged to ensure that recharge occurs relatively uniformly where wells are assumed to be normally operational for 90% of the time, but not including contingency well pump/ well failure.

- Flow meters and pressure gauges compatible with the pipe fittings to riser shall be provided for routine monitoring of flow rates and water pressure. The calibration and working condition of all flow meters and pressure gauges shall be demonstrated to the satisfaction of the Engineer prior to commencement of monitoring and shall be checked thereafter every two (2) months. Any defective equipment shall be repaired or replaced at the request of the Engineer.

- Zone of recharge shall be targeted for permeable (with permeability of more than 1.0E-7m/s) like F1, permeable Bukit Timah Residual Soil, permeable Jurong Formation Residual Soil, soil rock interface, fractured rock, etc., with sufficient screen area to achieve the required recharge capacity. Recharging of Fill layer shall be avoided.

- The entire recharge system is to be installed, tested and operationally ready for commission prior to commencing bulk excavation, and activated before the excavation commences, unless otherwise accepted by the Engineer.

- After completion of installation of recharge wells, functioning test for all recharge wells shall be conducted to confirm its effectiveness.

- The Contractor shall install a monitoring system of piezometer/water standpipe to test the effectiveness of recharge wells on ground water table to the acceptance of the Engineer.

- The Contractor shall submit the report on the testing results, including his assessment of his results immediately after the test.

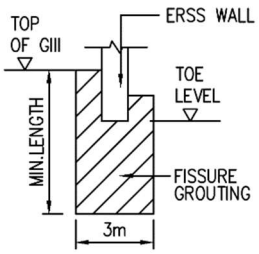
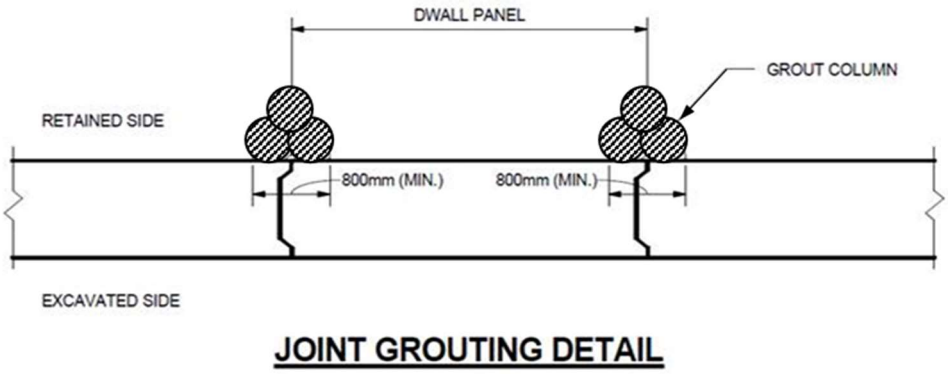


Figure 14.1 – Minimum Width of Fissure Grouting

14.8.1.2 Where the rock level is expected to be encountered below the formation level and the permeability of the soil between the ERSS toe and 10m below the toe is higher than 1.0E-7 m/s, curtain grouting in soil shall be carried out to provide a total cut off depth of at least 10m below the formation level. The curtain grouting shall achieve a coefficient of permeability of less than 5.0E-8 m/s.

14.8.2 Joint Grouting

Where fluvial sand and other permeable soils exist, the joints behind the diaphragm wall panel shall be grouted minimum 1m into Bukit Timah Residual Soil or Jurong Residual Soil or ground with permeability of 1.0E-8m/s, or to the acceptance of the Engineer, as shown below.



Minimum Number of Grout Columns at Joints of Diaphragm Wall Panels

At joint locations between two (2) types of ERSS walls where the end of one of the ERSS wall abuts perpendicularly or at an angle with the other ERSS wall, the joint shall be sealed with grout columns (minimum three columns) on the outer side of the excavation from ground level to the toe

14.9.9 In the event that surface subsidence or heave due to ground treatment is excessive in the opinion of the Engineer and QP(S), the Contractor shall immediately stop treatment works and propose alternative treatment methods, for acceptance by the Engineer and QP(S).

14.9.10 The Contractor shall submit to the Engineer daily records of the previous day's works duly endorsed by QP(S). Records are to be submitted for each drilled hole and shall include the following:

- Depth and diameter of drilling;
- Size, type and depth of casing used;
- Details of diameter, sleeved length and unsleeved length of any grout tubes installed in the drill holes;
- Quantity of sleeve grout used (if any); and
- Quantity, type, pressure and gel time of grout injected at each injection point, or per meter length in the case of continuous grouting.

14.9.11 Testing of the ground treatment area shall be in accordance with Materials and Workmanship Specification for Civil and Structural Works and LTA CDC. Failure to meet the required parameters will warrant re-grouting at the Contractor’s cost and time;

14.9.12 Details of the toxicity of all grouts shall be submitted to the Engineer and QP(S) for acceptance before they are used. Only environmentally friendly grouts will be accepted for use; and

14.9.13 During any injection grouting, the Contractor shall, with the permission of the relevant authorities, carry out inspections of all manholes and inspection pits for services within 20m of any area where injections are being carried out. Such inspections shall take place not less than once every two weeks, or at closer intervals if necessary, during the period of injection. Should grout material be found in any manhole, inspection pit, duct, pipe or other installations, the Contractor shall, under the direction of the Engineer and QP(S) and with the permission of the relevant authorities, remove all of the grout material. The Contractor shall also propose for the acceptance of the Engineer and QP(S) the changes to his method of working to prevent further grout ingress to adjacent services.