SPECIFICATION FOR FORMWORK PRESSURE GROUTING

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1. General

1.1. Submittals

The Tenderer in his Tender shall submit the following particulars for each of the non-shrink cement grout and sealant formulations to be used in the Works:

i. Material brand name, specification and properties stating Standards to which the materials comply.

ii. Name of manufacturer.

iii. Manufacturer's brochures on the use of the product.

iv. Mix composition of grout and sealant compound to be used.

v. Certified true copies of product Approval Certificate from a National or International Standards Institution.

1.2. Shrinkage Compensating Cement Grout Product

The grout to be used shall be of such temperature class suitable for use in tropical climate and of such viscosity grade suitable for application using pump and shall be able to fill the void completely.

1.3. Sealant Compound

The sealant compound shall be able to withstand the maximum grouting pressure without leak. Sealant shall be applied at positions as shown in the drawings or as directed by the S.O.

1.4. Quality Assurance

1.4.1. Labeling

All grout and sealant containers shall have the following markings:

i. Name of manufacturer.

ii. Manufacturer's product identification.

iii. Manufacturer's instructions for mixing.

iv. Warning for handling and toxicity.

1.4.2. Procedures For Use

The Contractor as a condition precedent to the use of any grout and sealant formulation, shall submit to the S.O. for his approval, the mixing and application procedures to be adopted in the Works.

1.4.3. Product Delivery, Storage And Handling

i. Delivery of Materials

All grout and sealant materials shall be delivered in manufacturer's sealed containers with labels legible and intact.

ii. Storage of Materials

All grout and sealant materials shall be properly stored in a weather proof store at temperatures between 4 ^{o}C - 38 ^{o}C or otherwise recommended by the manufacturer.

iii. Handling of Materials

All grout and sealant products shall be handled in a safe manner and in a way that shall avoid breaking the container seal.

1.5. Aggregate

The aggregate shall in general comply with MS29. All aggregates shall be hard, storage durable, clean and free from adherent coating and shall not contain harmful materials in sufficient quantity to affect adversely the strength or durability of the concrete or to attack the reinforcement. Aggregates shall be stored in such a manner as to prevent contamination by undesirable substance. The different types of aggregates shall be stored in separate bins and not be allowed to intermingle.

1.5.1. Fine Aggregate

The fine aggregates shall be naturally occurring fresh water sand. The aggregates shall not contain silt or other fine materials exceeding 3% by volume when tested according to the Standard Method given in MS30. Neither shall it contain organic material in sufficient quantity to show a darker colour than the standard depth of colour No. 3 when tested according to the method in MS30. The use of crushed stone sand shall not be permitted.

1.5.2. Coarse Aggregate

The coarse aggregate shall be crushed hard stone except that for work below ground level, only crushed granite will be used. The aggregate shall not contain clay lumps exceeding 1% by weight. A representative dry sample shall not show an increase in weight exceeding 8% after immersion in water when tested according to the method in MS30. It shall be well shaped and not flaky with the flakiness index not exceeding 35. The maximum nominal size of coarse aggregate shall be 20 mm.

Aggregate Grading

The analysis for the grading of aggregate shall be as described in MS30 and shall be within the limits specified below:

i. Fine aggregate (natural sand)

BS sieve	Percent passing
5 mm	95 - 100
2.36 mm	70 - 95
1.18 mm	45 - 85
0.60 mm	25 - 60
0.30 mm	5 - 30
0.15 mm	0 - 10

ii. Coarse aggregate (nominal size 20 mm)

BS sieve	Percent passing
20 mm	100
10 mm	25 - 55
5 mm	0 - 10

The grading between the limits specified above shall be to the approval of the S.O., and when tested as provided hereinafter shall approximate closely to the grading of the approved samples. If it should be found necessary, the fine aggregate shall be washed and/or screened to comply with foregoing standards and the requirements of the S.O.

2. Execution

2.1. Temporary Supports And Props

Before repair may be done to any structural member, the Contractor shall provide adequate supports and props to the structural members to ensure the safety and stability of the members and the structure is not impaired. The support and prop system shall be of such configuration and design approved by the S.O. Where additional supports or props are deemed necessary by the S.O., these shall be provided by the Contractor at his own cost.

2.2. Preparation Of Concrete Surfaces

2.2.1. Removal Of Unsound Concrete

The spalled, damaged or unsound concrete shall first be removed to expose sound parent concrete. The removal and surface preparation work shall be carried out using mechanical or other equipment approved by the S.O.

2.2.2. Cleaning Existing Steel Reinforcement

The contractor shall remove all rust, oil, scale or any other deleterious matter from the steel surfaces before applying the bonding agent.

After cleaning, the contractor shall inspect the condition of the reinforcement by measuring the diameter of each reinforcing bar. If the cross-sectional area of the reinforcement has been reduced by more than 10%, then additional reinforcement shall be installed. The total area of reinforcement shall not be less than the cross-sectional area of original reinforcement. The additional reinforcement shall be installed with minimum lap length of 30 diameter of the additional reinforcement. The contractor shall inform the S.O. of the location and the number of additional reinforcement.

2.2.3. Care During Works

The Contractor shall at all times during the hacking, grooving and drilling works exercise due care against cutting into any reinforcement. Where a reinforcement is cut or damaged, the Contractor shall notify the S.O. who shall decide the manner in which the reinforcement shall be repaired, these repair shall be carried out at the Contractor's own cost and no claim for extra in this respect shall be allowed.

2.3. Inspection Of Concrete Surfaces Prior To Grouting

All concrete surface shall be inspected by the S.O. before fixing the formwork. The surface shall be free of dust, dirt, oil or any other deleterious matter. The surface shall be properly dry to the satisfaction of the S.O.

2.4. Non-Shrink Cement Grout And Sealant Compound Mixes

The mixing procedure of the grout and sealant compound mixes composition shall be strictly in accordance with the manufacturer's instructions.

The grout and sealant compound shall be mixed in a clean container free from harmful residual or foreign particles. The mix shall be thoroughly blended using a mechanical mixer to a uniform and homogenous mixture. Small batches of mix not exceeding 1 litre may be hand-mixed by use of spatulas, palette knives or similar devices to obtain a uniform homogenous mixture. Where a paddle type mechanical mixer is used, care shall be taken to prevent air entrapment in the mixture. Each mix shall be of such amount that it can be immediately used before the material gels. Any mix which has been gelled shall not be tampered for use but shall be discarded forthwith.

2.5. Installation Of Entry Port Fitting

The contractor shall provide and install copper pipe of appropriate diameter and length complete with shut-off nipple or valve into the pre-drilled holes provided for injection entry port. The pipe stem shall be properly cleaned of dirt, oil and grease prior to installation. The stem shall be properly bonded using sealant compound. The contractor shall ensure that the opening through the hole and pipe is clear from being blocked by sealant compound.

2.6. Sealing Of Formwork

The sealing compound shall be applied to the formwork at positions as shown in the drawings using appropriate tools as directed by the S.O.

The compound shall be properly worked into place and consolidated thoroughly so that all contact surfaces are wetted by the compound and entrained air reduced to the level recommended by the manufacturer to form well bonded and leak free seal.

The sealant shall be allowed to cure for two days or as manufacturer's instruction prior to injection of grout.

2.7. Grouting

2.7.1. Grouting Equipment

The Contractor shall provide sufficient number of grouting equipment for the Works. The grout injection pump shall be of hydraulic injection type, in good working condition and capable of injecting the grouting material under pressure up to 0.275 N/mm^2 (40 psi). The pump shall be fitted with all necessary items including pressure hose, injector and feeder tank.

A direct reading pressure gauge properly calibrated shall be fitted on the discharge hole to allow injection pressure readings to be taken.

A device capable of measuring accurately the quantity of grout injected shall be fitted to the injection system. Where volumetric meter is used for measuring, it shall provide direct reading in millilitres.

The meter shall have been calibrated no later than 3 preceding months by a recognised test agency. The Contractor shall furnish the S.O. with such calibration certificate as proof.

Where other means of volume measurement is to be used, it shall be to the approval of the S.O.

2.7.2. Cleaning Of Equipment

All equipment used for grout shall be thoroughly cleaned after every use. The Contractor shall ensure that the equipment are dry and free from oil, dirt, solvent or other deleterious matter before each time they are to be reused.

2.7.3. Shrinkage Compensated Cement Grout Injection

The grout shall be injected into the formwork through the injection port using the injection pump fittings.

For horizontal concrete member such as slab and beam, injection proceeds from one end to the other through adjacent ports. The grout shall be injected from the lowest level proceeding upwards.

For vertical member, the injection shall commence from the bottom upwards through adjacent ports.

Injection of grout through one entry port shall continue until grout starts to come out from the adjacent port. At this point the injection port shall be sealed off by closing the valve or nipple. Injection shall then proceed from the adjacent port where the grout had just appeared. This sequence shall be followed until all ports are injected.

During injection, the contractor shall ensure that the injection rate and pressure is such that all voids are completely filled without damage to the surface seal or structure. All precautions must be taken to prevent entrapment of air in the grout. Where leak occurs in the surface seal or formwork, the injection shall be stopped. All leaks shall be resealed using sealant compound and allowed to cure before injection is recommenced.

2.7.4. Cutting-off Entry Port Pipe

Where the concrete surface is to receive no further treatment or coat of finishing, the stem of the entry port pipe projecting beyond the surface of concrete shall be cut-off flushed with the concrete surface using a suitable tool approved by the S.O. The cutting operation shall not begin until the cement grout has sufficiently cured but in no case earlier than 7 days after completion of grout injection. Care shall be taken during the cutting-off work to prevent damage to the surrounding sealant or concrete.

2.7.5. Record Of Grouting

The Contractor shall maintain continuous record of all grouting works. The record, in duplicate, shall be in such form approved by the S.O. At each location of the grouting work, the following data shall be provided:

i. Identification of grouted member, stating type e.g. slab, beam or column and reference position of grouting.

ii. General description of grouting and sketch showing configuration and total area.

iii. Grouting works information.

iv. Date of grouting.

v. Name of the Contractor's grouting operators.

vi. Amount of grouting and sealant material used.

The amount of grouting and sealant material shall be the actual quantity used for grouting works only.

These shall not include any quantity of grouting and sealant material which are discarded.

The Contractor shall submit the record in duplicate to the S.O.'s Site Representative immediately on completion of each grouting works for verification. Thereafter the verified record shall be jointly signed by the Contractor and the S.O.'s representative. A copy of the record shall be kept by the S.O. and the other shall be retained by the Contractor. The information from these records shall be the basis of computing the quantity for grouting works under the Contract.

2.8. Testing

2.8.1. Pressure Grout Samples

6 numbers of 150x150x150 mm cubes shall be taken and tested as described in BS1881. Preparation of the samples shall comply with the following procedure:

i. Prepare six numbers 150x150x150mm cube mould with top and bottom end exposed.

ii. Provide for 25 mm thick formwork at both ends and filled the cube mould with the approved aggregate.

iii. Install grout pipes at top and bottom end of the cube mould.

iv. Plug one end of the grout pipe and pump the cement grout (1:1 cement:sand with water/cement ratio of 0.45) with non-shrink additive and maintain pressure for 2 to 3 minutes.

v. The plugged grout pipe is released and closed again to eliminate any air pockets in the cube.

vi. The final pressure of 0.275 N/mm^2 (40 psi) is then maintained for 5 minutes.

2.8.2. Preliminary Testing

Prior to the work being carried out, the contractor shall submit four samples of the non-shrink cement grout for testing purposes.

All samples shall be given a number, date of preparation, its mix, mortar and bonding agent used and name of operator preparing the sample.

The samples submitted shall be ready for testing at any laboratory approved by the S.O. Final approval for the work to start will depend on the results of this test.

Compressive Strength Test for grout material shall be in accordance to BS1881. The minimum compressive strength shall be 17 N/mm^2 at 7 days and 25 N/mm^2 at 28 days.

All expenses to carry out this test shall be borne by the contractor. The test shall not be a reason for any delay on the part of the contractor to carry out the work.

2.8.3. Testing During Construction

While the works are being carried out, the contractor shall furnish to the S.O. prepared samples of aggregate and grout as placed. Compressive strength test shall be carried out in accordance to BS1881, The sample shall have a minimum strength of 17 N/mm^2 at 7 days and 20 N/mm^2 at 28 days.

The contractor shall provide all facilities in the sampling, making, curing and testing of the cubes.

2.8.4. Certificates

The contractor shall furnish all manufacturers certificates for materials and equipments used in the works and where applicable JKR or SIRIM approval should be obtained.