

**SPECIFICATION
FOR REPAIR TO SPALL AND
DAMAGED CONCRETE
BY
SPRAYED CONCRETE**

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SPECIFICATION FOR REPAIR TO SPALLS AND DAMAGED CONCRETE BY SPRAYED CONCRETE

1. General

Unless otherwise directed by the S.O. all concrete that has spalled off from the structure shall be repaired by sprayed concrete or guniting. The term “gunite” refers to the concrete produced by the projection of a wetted sand cement mixture onto an area by means of an air pressure vessel termed as gun.

2. Submittals

The tenderer is required to furnish the following information as part of their tender evaluation:

- i. A list of names of competent operators who have a minimum of three years structural repair experience. State their names, I.C. no. and list of employment with any other contractor for the last five years.

On award of the contract, the contractor shall submit to the S.O. the following:

- i. Information concerning the source and quality of materials.
- ii. Furnish representative samples for materials testing, mix and proportion testing.

3. Delivery, Handling And Storage

Materials are to be properly delivered and handled to prevent contamination, segregation or damage of materials.

Cement is to be stored in a watertight enclosure to protect it against dampness and contamination.

4. Execution

4.1. Wet Mixed Spray Application

Order of works:

- i. Cleaning of concrete surfaces.
- ii. Cutting-out defective concrete and cracks as per specification.
- iii. Clean steel reinforcement and prime the reinforcement with a cementitious primer.

- iv. Cut-out corroded reinforcement and replace as per specification, clean and prime reinforcement with cementitious primer.
- v. Pre-damp substrate with clean potable water, saturated but surface dry.
- vi. Apply a site wet-mixed repair mortar by wet-spray application.
- vii. Finish smooth the surface with a wood float or straight edges.
- viii. Undertake adequate curing.
- ix. Apply protective coating.

4.2. Temporary Support and Props

Before any repair may be done to any structural members, the Contractor shall provide adequate supports and props to the structural members to ensure the safety and stability of the member and the structure are not impaired. The support and prop system shall be of such configuration and design approved by the S.O.

4.3. Cleaning Of Overall Concrete Surfaces

All coatings on exposed concrete shall be removed by mechanical means.

All exposed concrete surfaces shall be cleaned and prepared to achieve a laitance and contamination free open-textured concrete surface. This must full expose all surface defects including cracks, honeycombing, blowholes, etc. and remove all surface contaminants including moss, lichens, algae, shells, oil, grease, etc.

The Contractor shall provide adequate protection to all adjoining elements during the aforementioned cleaning operation. Any damage occurs to these adjoining elements as a result of inadequate protection and or negligence of the Contractor shall be rectified by the Contractor to the satisfaction of the S.O.

All adjoining elements shall be thoroughly cleaned of all abrasive or other cleaning material which remains upon or in such element on completion of the aforementioned concrete cleaning operation.

4.4. Cutting-out Of Defective Concrete

The Areas to be repaired, in general, are as indicated on the drawings and or as indicated by the S.O. All the defective areas are to be delineated and marked out on the site as agreed with the S.O. before proceeding or commencing with the repair works. The area may be adjusted by the S.O. as work proceeds according to the conditions found.

The extent for which concrete is to be cut-out for the purpose of repair must be noted on suitable record sheets and approved by the S.O. prior to commencing such repairs.

All designated contaminated or defective concrete areas that have been agreed upon shall be removed by using appropriate tools and equipment to sound concrete.

Where this depth corresponds to the depths of concrete cover and thereby exposes reinforcement, breaking out shall continue to expose full circumference of the steel and to a further depth of 20 mm or as directed by the S.O. Breaking out shall continue along the reinforcement until non-corroded steel is reached and shall continue 100 mm beyond this point or as directed by the S.O. Special care shall be exercised to ensure that any reinforcement exposed is not cut or damaged.

No reinforcement shall be rebent or cut out without the consent of the S.O.

The depth of breakout on the edge of any repair area shall be a minimum of 10 mm depth and feather edges will not be accepted. To achieve this, the perimeter of the area to be repaired shall first be cut to a depth of 10 mm using a suitable tool.

This preparation shall be such as to leave a sound exposed concrete substrate free from dust, loose particles and any deleterious matter.

4.5. Reinforcement Preparation

All exposed reinforcement shall be cleaned and free of all corrosion products, oil or other coatings interfering with the bonding by wire brushing or other approved means. Reinforcement shall be rigidly secured in positions so as to have a minimum cover as specified.

When the corrosion products have been removed, and if directed by the S.O., the diameter of the reinforcement shall be measured. In the locations where the corrosion is severe and more than 10% (ten percent) of the reinforcement area has been lost, the S.O. is to be immediately informed before proceeding further with the repair. New reinforcement shall be fixed and lapped with the existing bar with a lap length of 40 diameter. The mild steel and high tensile reinforcement shall comply with MS 146. Steel fabric shall not be applied in roll.

Reinforcement damaged during the removal of concrete or the preparation process shall be repaired or replaced by the Contractor at his own expense in accordance with the specifications.

After cleaning but before applying the prime coat, the reinforcement shall be air cleaned to remove dust and other loose material.

4.6. Reinforcement Priming

The priming coat is to be applied within 2 hours after preparing and cleaning of the reinforcement.

Where parts of the reinforcement bars remain embedded in the sound concrete, the primer is to overlap onto the concrete by approximately 5 mm but care is to be exercised in avoiding over-paint onto the surrounding concrete.

One (1) coat of primer shall be applied.

The primer shall be a cementitious material according to BS 4652:1971 or equivalent and to be approved by the S.O. before application.

The application of the primer shall be in accordance with the manufacturer's recommendations and technical data sheets.

4.7. Placing Of Reinforcement

4.7.1. Steel Reinforcement

Steel reinforcement shall be stored in clean conditions. It shall be clean and free from loose rust, mild scale, oil, grease, paint and dirt at the time of fixing in position and subsequent priming.

No concrete shall be placed until the reinforcement has been inspected and approved by the S.O.

The Contractor shall furnish, for reinforcement supplied by him, manufacturer's certificates and these shall be submitted for acceptance by the S.O. before any material is brought onto the site.

In addition, the Contractor shall, on request, furnish the S.O. with samples of reinforcement to MS 146, and notwithstanding any previous acceptance of the manufacturer's test certificate, that reinforcement represented by the sample may be rejected by the S.O. and shall require its removal from the works site.

4.7.2. Cutting And Bending Of Reinforcement

Bars shall be cut and bent cold in approved bar-bending machine to the correct dimensions shown in the drawings and in accordance with BS 4466:1969.

4.7.3. Placing Of Reinforcement

Reinforcement shall be placed and maintained in the position shown in the drawings. Unless otherwise permitted by the S.O., the main reinforcement and the links shall be tied together with the wire described in the drawings and the ends of the wire shall be turned into the main body of the concrete.

The position of the reinforcement in the formwork (if it is used) shall be ensured by means of suitable and sufficient plastic or concrete spacers. The minimum distance between the plastic spacers shall be 1.0 meter. Before application of the spacer, the Contractor shall submit samples of the spacers to be used for the work to the S.O. and obtain the approval from the S.O.

No splices shall be made in the reinforcement except where described in the contract or where approved by the S.O.

4.7.4. Welding Of Reinforcement

Reinforcement shall be fillet welded. Fillet weld shall be carried out in accordance with BS 5135:1974.

4.8. Predamping Of Substrate

The concrete shall be presoaked with a spray of clean portable water. If the concrete substrate is particularly dry or absorbent, it shall be sprayed again before continuing. No free surface water shall be present.

4.9. Application Of Repair Mortar

The repair mortar shall be a site mix mortar containing pre-bagged ordinary portland cement, superplasticiser and non-shrink additive.

The nominal mix proportions for the grout shall be:

- i. Ordinary Portland Cement (OPC) 50 kg (1 bag)
- ii. Water 22.5 litres (water/cement ratio of 0.45)
- iii. Expansion additive to manufacturer's recommendation.
- iv. Non-shrink additive to manufacturer's recommendation
- v. Minimum cube strength of the grout at 7 days shall be 20 N/mm².
- vi. Minimum cube strength of the grout at 28 days shall be 30 N/mm².

The mortar application shall be by the wet-mix spray applied process using a suitable spray machine. The machine shall be capable of continuously mixing pre-bagged material, of transporting the wet-mix under pressure through flexible 40 mm ID delivery hoses, of thoroughly mixing the material with air at the nozzle, and or subsequently discharging the wetted-mix in smooth stream at sufficient velocity, to ensure uniform compaction and thickness build up on the surface being sprayed.

Where the total thickness of mortar required is greater than that which can be achieved in one layer without sagging or slumping, the material shall be applied in accordance with the manufacturer's recommendations, to achieve the desired profile.

The materials are required to be compatible with the original concrete substrate.

The mixing shall be carried out strictly in accordance with the manufacturer's recommendations. The Contractor is to ensure that the correct equipment is on site and has been allowed for in the Tender.

The powder shall always be added to the water. In no circumstances shall more water be used in the mix than specified by the manufacturer. Remixing and retempering shall not be permitted.

Particular care shall be taken in the application of the repair material. Where necessary it should be built up in successive wet on wet layers to the required profile.

If sagging occurs, the material must be completely removed and the void filled in two or more successive applications, in accordance with the manufacturer's recommendations.

Where thickness of the sprayed concrete is more than 25 mm, a steel fabric B385 (100 mm x 200 mm) shall be positioned approximately 20 mm short of the finished surface to provide restraint to the expansive force.

The Contractor shall ensure that the repair mortar is placed behind the reinforcement before any material is allowed to accumulate on the face of the reinforcement. No rebound shall be mixed into any batch and no batch shall be used in the work if it has stood for more than half an hour after mixing.

The finish shall be finished off smooth by wood float or straight edge.

4.10. Curing

4.10.1. Initial Curing

Immediately after finishing, the contractor shall keep the sprayed mortar continuously moist for at least 24 hours. The contractor shall adopt one of the following methods:

- i. Continue sprinkling
- ii. Absorptive mat or fabric, or other covering kept continuously wet.

4.10.2. Final Curing

The contractor shall provide additional curing immediately after initial curing and before the sprayed mortar has dried. The following method shall be adopted.

- i. Continue the method used in initial curing.
- ii. Other moisture retaining coverings approved by the S.O.

4.10.3. Duration Of Curing

The contractor shall ensure that curing will be continued for the first seven (7) days after spraying. During the curing period, the sprayed mortar is to be maintained at a temperature above 4 °C and in a moist condition, as specified in paragraph 4.10.1 and 4.10.2. Rapid drying at the end of the curing period must be prevented.

5. Testing

5.1. Preconstruction Testing

Prior to the work being carried out, the contractor shall prepare the following for examination and testing purposes:

- i. Test panel at least 750 mm x 750 mm for the proposed mix and for each shooting position to be encountered during the course of the work (i.e vertical, horizontal position etc.).

The same reinforcement as the existing structure shall be provided in at least half of the panel to test for proper embedment of reinforcing steel. The test panel shall be fabricated to the same thickness of the existing slab. The contractor shall ensure that the work be carried out by the contractor's regular nozzleman.

The test panel shall be cured in the same manner as the work. Prior to testing the core taken from the test panel shall be soaked in water for a duration of 40 hours.

The contractor shall take at least five cores (100 mm diameter) for compressive strength testing purposes as approved by the S.O.

The prepared core sample shall have a diameter to length ratio of between 1.0 to 1.2

The average compressive strength of the five cores taken from the test panel must equal or exceed 25 N/mm^2 with no individual core less than $0.85 f_{cu}$ (21.3 N/mm^2) at 28 days.

Approval for the actual work to be carried out will be based on the results obtained from the cores.

The contractor shall submit the prepared cored samples to an approved laboratory for testing.

All expenses incurred in carrying out the test will be borne by the contractor. The test preparation and execution shall in no way be a reason for any delay in meeting the contract period.

All tests shall be carried out in accordance with BS 1881:1970.

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