SPECIFICATION FOR CONCRETE CRACK REPAIR

JKR 20601-0250-18

BAHAGIAN PERKHIDMATAN FORENSIK STRUKTUR
CAWANGAN KEJURUTERAAN AWAM DAN STRUKTUR
IBU PEJABAT JKR MALAYSIA
KUALA LUMPUR

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1.0 GENERAL

This specification shall be used for concrete structure with the following crack categories:

i. Crack width less than or equal to 0.3mm; and
ii. Crack width more than 0.3mm but less than or equal to 3.0mm

1.1 Submittals

The contractor shall submit the following particulars for each of crack repair works:

i. Material brand name, specification and properties stating standards to which the materials comply;
ii. Name of manufacturer;
iii. Manufacturer's brochures of the product;
iv. Method statement for each crack repair works;
v. Copy of product approval certificate from a National or International Standards Institution; and
vi. Copy of product injectability test result.

1.2 Materials

1.2.1 Surface Seal Polymer Compound

The polymer compound for surface seal shall be of thixotropic nature and comply with the following minimum requirement when tested with the respective European Standard (EN) as specified below:

Compressive Strength (BS EN 12190)	≥ 50 N/mm^2
Tensile Bond Strength (BS EN 12618-2)	≥ 2.0 N/mm^2 Cohesive Failure of Substrate

The compound shall be of such viscosity grade that it does not sag when applied in putty form into a groove in overhead application. The compound shall on curing, able to withstand the maximum grouting pressure without leak.

1.2.2 Polymer Resin

The polymer resin for concrete cracks injection shall comply with the following minimum requirement when tested with the respective European Standard (EN) as specified below:

Compressive Strength (BS EN 12190)	≥ 50 N/mm^2
Tensile Bond Strength (BS EN 12618-2)	≥ 2.0 N/mm^2 Cohesive Failure of Substrate
Viscosity (EN ISO 3219)	110 - 300 mPa.s

The polymer resin shall be of such temperature class suitable for use in tropical climates and of such viscosity grade suitable for pump application. It should be of two components with very low viscosity for injection and pouring. It shall also be polymerized without shrinkage and once hardened is waterproof and resistant towards chemical agents present in the atmosphere.

1.3 Quality Assurance

1.3.1 Labeling

All containers shall have the following markings:

i. Name of manufacturer;
ii. Manufacturer's product identification;
iii. Manufacturer's instructions for mixing; and
iv. Warning for handling and toxicity, where applicable.

1.3.2 Procedure for Use

The Contractor shall submit to the S.O. for his approval, the mixing and application procedures to be adopted in the works.

1.3.3 Product Delivery, Storage and Handling

1.3.3.1 Delivery of Materials

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

1.3.3.2 Date of Expiry

Expired repair materials should not be used on site.

1.3.3.3 Storage of Materials

All repair materials shall be properly stored in weatherproof store at temperatures between 5°C - 38°C or otherwise recommended by the manufacturer.

1.3.3.4 Handling of Materials

All repair materials shall be handled in a safe manner and in a way that shall avoid breaking container seal.

1.4 Confirmatory Crack Survey

Prior to the commencement of the work, the contractor shall conduct a survey to identify all cracks which would require injection repair. If, crack location drawing supplied in the contract, the contractor shall conduct confirmatory crack survey to confirm the location of the cracks. The locations for the repair should be clearly marked out and identified. The crack mapping record shall comply with clause 1.5.4 of this specification.

1.5 Execution of Works

Approval of the S.O. is required prior to commencement of any crack repair works.

1.5.1 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 member and the structure is not impaired. The support and prop system shall be of such configuration and design according to the national standard and approved by the S.O.

1.5.2 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 reinforcement is cut or damaged, the Contractor shall notify the S.O. who shall decide the manner in which the reinforcement shall be repaired, all at the Contractor's own cost and no claim for extra in this respect shall be allowed.

1.5.3 Inspection of Concrete Surfaces and Cracks Prior to Surface Sealing

All concrete surfaces and cracks shall be inspected by the Contractor before application of surface seal polymer. The surfaces shall be free from loose material and contaminants. The surface shall be sufficiently dry. The Contractor should seek the approval of the S.O. before commencement of the surface sealing works.

1.5.4 Record of Crack Repair Works

The Contractor shall maintain continuous record of all crack repair works. The record, in duplicate, shall be in such form approved by the S.O. The repair drawing shall consist of the following but not limited to the information as follows:

i. Identification of crack member type; e.g. slab, beam, column;
ii. Provide general description of crack and sketch showing crack pattern;

iii. Maximum width and length of crack; and
iv. Picture of crack before, during and after the repair works.

The Contractor shall submit the record in duplicate to the S.O. immediately on completion of each crack repair work for verification. Thereafter the verified record shall be jointly signed by the Contractor and the S.O. The original copy of the record shall be kept by the S.O., and the signed duplicate copy returned to the Contractor. The information from the record shall be the basis of computing the actual final quantity for crack repair works under the Contract.

1.6 Testing Quality Control

Unless otherwise specified in the contract, the Contractor shall propose a testing quality control plan for the S.O. approval. The proposed plan shall comply with Clause 9.3, BS EN 1504-10. All cost for execution of the approved plan shall deem to be included in the contractors cost for the works.

2.0 CRACK REPAIR WORKS PROCEDURE

2.1 Crack Width Less Than or Equal to 0.3mm

2.1.1 Preparation of Concrete Surfaces

Where cracks to be repaired are located in concrete that have spalled or otherwise been damaged or are unsound, such concrete shall first be removed to expose sound parent concrete free of loose and unsound material. The removal and surface preparation work shall be carried out using mechanical equipment approved by the S.O.

2.1.2 Routing of Cracks

All cracks to be repaired shall be routed along its length with sharp-edged V-grooves to a depth and width of approximately 10mm respectively using light chipping mechanical hammers or cutting machine approved by the S.O.

2.1.3 Cleaning the Cracks

On completion of the groove routing work, the exposed concrete surface and the inside of the cracks shall be thoroughly cleaned using water. The water used shall be clean water free of contaminants. The surfaces and cracks shall be allowed to air dry and thereafter they shall be cleaned and dried using high pressure compressed air jet. The equipment supplying the compressed air shall be equipped with efficient oil and water trap approved by the S.O. to prevent contamination to the concrete surface.

2.1.4 Sealing of V-Groove

The composition of surface seal polymers compound, to be used in a mix shall be strictly in accordance with the manufacturer instructions.

The surface seal polymer compound shall be mixed in a clear container free from harmful residue or foreign particles. The mix shall be thoroughly blended using mechanical mixer to a uniform and homogeneous 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. When paddle type mechanical mixer is used, care shall be taken to prevent air entrapment in the mixture. Each mix should be of such amount that it can be immediately used before the material gels.

The compound shall be applied to the dry groove in the crack, by trowel or such other means approved 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. It shall allowed to cured to form well bonded and leak free seal.

2.1.5 Finishes Reinstatement

The surface of the seal shall be finished flushed with adjacent concrete. Grinding machine shall be used to flush the excessive sealant.

2.2 Crack Width More Than 0.3mm But Less Than or Equal to 3.0mm

2.2.1 Preparation of Concrete Surfaces

Refer to **2.1.1**

2.2.2 Installation of Packer

The Contractor shall provide and install packer of appropriate diameter and length complete with shut-off nipple or valve into the pre-drilled holes provided for injection of packer point. Hole for installation of packer for injecting polymer resin shall be provided by the contractor at specified distance along the crack. The spacing of holes shall be such that complete filling of the crack by polymer resin can be achieved.

The packer holes shall be properly cleaned from loose material and contaminants prior to installation. The surface packer shall be properly bonded using surface seal polymer, care being taken to ensure the opening through the hole and packer point is clear from being blocked by polymer.

For surface packers, the distance between packers shall not be more than 2/3 of the thickness or depth of the element.

For mechanical drilled-in packer, the hole diameter should be sufficient for insertion of packers and should be at an angle of 45˚-60˚ intersecting the crack lines, in a staggered pattern at both sides of the groove lines. The distance between packers shall not be more than 1/2 to the thickness or depth of the element. The maximum distance of packer to the center of the

crack lines shall not be more than 50mm. For drilled in mechanical packers, the contractor shall provide suitable mechanical packers with irreversible ball bearing.

2.2.3 Cleaning Cracks and Holes

On completion of drilling work, the exposed concrete surface and the inside of the cracks shall be thoroughly cleaned using water. The water used shall be clean water free of contaminants. The surfaces and cracks shall be allowed to air dry and thereafter they shall be cleaned and dried using high pressure compressed air jet. The equipment supplying the compressed air shall be equipped with efficient oil and water trap approved by the S.O. to prevent contamination to the concrete surface.

2.2.4 Sealing of Cracks

The composition of surface seal polymers compound, to be used in a mix shall be strictly in accordance with the manufacturer instructions.

The surface seal polymer compound shall be mixed in a clear container free from harmful residue or foreign particles. The mix shall be thoroughly blended using mechanical mixer to a uniform and homogeneous 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. When paddle type mechanical mixer is used, care shall be taken to prevent air entrapment in the mixture. Each mix should be of such amount that it can be immediately used before the material gels.

The compound shall be applied to the dry crack, by trowel or such other means approved 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. It shall be allowed to cure to form well bonded and leak free seal.

The surface of the seal shall be finished flushed with adjacent concrete. The surface seal polymer shall be allowed to cure base on manufacturer recommendation prior to injection of polymer resin.

2.2.5 Injection Equipment

The Contractor shall provide sufficient number of injection equipment for the Works. Injection pump shall be the hydraulic type, in good working condition and capable of injecting the polymer resin material under pressure up to 276 kPa or sufficient to fill up the crack. The pump shall be fitted with all the necessary items including pressure hose, injector and feeder tank.

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

The meter shall be calibrated no later than three (3) preceding months by a recognized test agency. The Contractor shall furnish the S.O. 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.

2.2.6 Cleaning of Equipment

All equipment used for injection 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.

2.2.7 Polymer Resin Injection

Polymer resin shall be injected into the crack through the packer point using the injection pump fittings.

For horizontal member, injection of the polymer resin shall begin at the widest section. For vertical member, the injection of polymer resin shall begin at the lowest entry port.

If surface packers are used, injection of polymer resin through one packer point shall continue until polymer resin starts to come out from the adjacent port. At this point the injection packer point shall be sealed off by closing the valve or nipple. Injection shall proceed to the adjacent packer point where the polymer resin has just appeared. The sequence shall be followed until all packer point are injected.

If mechanical drilled-in packers are used, the injection should be stop when the injection pump has reached its maximum build up pressure. Injection shall proceed to the adjacent packer point. The sequence shall be followed until all packer point is injected.

During injection, care shall be taken to ensure that the injection rate and pressure is such that all cracks are completely filled without damage to the surface seal or structure. All precautions must be taken to prevent entrapment of air in the polymer resin.

When leak occurs in the surface seal or new crack plane emerges, the injection shall be stop. All leaks shall be resealed using surface seal polymer and allowed to cure before injection is recommenced.

New crack plane which emerges shall be V-groove, cleaned, provided with packer point, sealed and cured as described herein before prior to recommencement of polymer resin injection. The grooving work on such crack shall not begin until adjacent injection polymer resin has sufficiently cured.

2.2.8 Finishes Reinstatement

Where the concrete surface is to receive no further treatment or coat of finishing, the stem of the packer point pipe projecting beyond the surface of concrete shall be cut of flushed with the concrete surface using suitable tool approved by the S.O. The cutting operation shall not begin until the epoxy polymer resin has sufficiently cured according to the manufacturer. Care shall be taken during the cutting off work to prevent damage to the surrounding epoxy polymer sealant or concrete.

The surface of the seal shall be finished flushed with adjacent concrete. Grinding machine shall be used to flush the excessive sealant.

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