

Manish V. Doshi	Repair, Strengthening & Facelifting Specifications
Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

SPECIFICATIONS BOOKLET

Repair, Strengthening & Facelifting Works

Rajkot Nagrik Sahakari Bank Ltd., Parabazar Branch, Rajkot

Client / Project	Rajkot Nagrik Sahakari Bank Ltd., Parabazar Branch, Rajkot
Location	Rajkot, Gujarat
Prepared By	Manish V. Doshi, Consultant Structural & Civil Engineer, Rajkot
Date	05 February 2026

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A

Specification, Methodology, Mode of Measurement and BOQ Descriptions

RCC Structural Repair & Rehabilitation

**For structural RCC components (beams, slabs, columns, walls,
cantilevers, stair slabs, etc.)**

with typical parent concrete grade M15 (existing construction)

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1. Scope and Intent

1.1 Scope

This specification covers repair and rehabilitation of structural RCC members affected by spalling, delamination, honeycombing, cover loss, exposed or corroded reinforcement, localized sectional damage, and dormant/stabilized cracks requiring bonding by epoxy injection.

Structural members include: beams (primary/secondary), slabs, columns, shear walls, lintel beams behaving structurally, stair waist slabs/landings, cantilever projections that are structural, plinth beams, and foundations/footings (where accessible).

1.2 Intent

- Restore sectional capacity, durability and load-path continuity (monolithic action).
- Arrest/mitigate reinforcement corrosion by proper exposure, cleaning, passivation and dense repair material.
- Repair cracks (where suitable) by low-viscosity epoxy injection with controlled pressure and sequence.
- Ensure quality assurance through defined hold points, inspection records and acceptance checks.

1.3 Exclusions / Separate Design Items

The following shall not be executed under this specification without separate structural design, drawings and BOQ items:

- RCC jacketing, steel jacketing, FRP wrapping, external post-tensioning.
- Member replacement, major recasting, enlargement, underpinning, foundation strengthening.
- Global stability issues, excessive deflection, foundation settlement correction.
- Active cracks due to ongoing movement, vibration, thermal cycling or continuing corrosion (without arresting the cause).

2. Codes and Standards (Latest Revisions)

- IS 456 - Plain and Reinforced Concrete (workmanship, cover, curing, durability).
- IS 1786 - High strength deformed steel bars and wires for concrete reinforcement.
- IS 15988 - Seismic evaluation and strengthening of existing RCC buildings.
- IS 13311 (Part 1 & 2) - Non-destructive testing of concrete (UPV and Rebound Hammer).
- IS 516 (relevant parts) - Methods of tests for strength of concrete.
- IS 383 / IS 9103 - Aggregates / Admixtures (where applicable).

Where BIS provisions are silent for proprietary epoxy systems, internationally accepted references may be used (e.g., ASTM C881, ACI 224.1R) subject to approval by Engineer-in-Charge.

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3. Pre-Repair Investigation and Repair Selection

3.1 Joint Inspection and Distress Mapping (Mandatory)

Before starting any repair work, the Contractor, Project Engineer and Structural Consultant shall jointly:

- Identify and mark delaminated/hollow zones by tapping/hammer sound.
- Map cracks: record crack width, orientation, member type and accessibility.
- Identify moisture sources (leakage points, negative slope, rainwater ingress, plumbing, etc.).
- Classify cracks as dormant/stabilized versus active (monitoring where required).

3.2 NDT / Checks (As Directed)

Depending on condition and extent, the Engineer-in-Charge may direct the following tests:

- Rebound Hammer and UPV (IS 13311) for comparative assessment.
- Cover meter scanning to confirm cover and bar location.
- Carbonation depth, chloride content, half-cell potential tests (for corrosion assessment).

3.3 Repair System Selection (Primary Rule)

A) Section restoration (spalling/delamination/corrosion damage):

- Average repair thickness ≤ 40 mm: Polymer Modified Repair Mortar (PMRM), thixotropic.
- Average repair thickness > 40 mm: Non-shrink micro-concrete / flowable repair concrete with shuttering.

B) Structural crack bonding:

- Dormant/stabilized cracks requiring monolithic action: Low viscosity epoxy injection.
- Active/moving cracks: treat as joint/flexible system or arrest the cause first; epoxy injection shall not be used as a stand-alone measure.

4. Materials

4.1 Repair Mortar (PMRM)

Prepacked or approved site-batched polymer modified repair mortar, thixotropic, shrinkage-controlled, suitable for vertical/overhead applications. Layer thickness per pass shall comply with the approved datasheet.

4.2 Micro-Concrete / Repair Concrete

Prepacked or approved repair micro-concrete, non-shrink/low-shrink, flowable or pumpable, capable of fully encapsulating reinforcement without voids. Leak-proof shuttering and venting shall be mandatory.

4.3 Strength Compatibility (M15 Parent Concrete)

Existing RCC may have parent concrete grade around M15. Repair materials shall be compatible and not weaker than parent concrete.

Unless otherwise approved, minimum target strength of repair material shall be at least M20 equivalent at 28

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days; M25-M30 is preferred for external/aggressive exposure conditions, subject to product datasheet and Engineer approval.

4.4 Reinforcement / Dowels and Accessories

Reinforcement steel shall comply with IS 1786. Where additional dowels/shear pins are required, they shall be installed with approved chemical anchoring systems. All binding wire shall be galvanized of appropriate thickness.

4.5 Corrosion Treatment

Rust removal shall be by mechanical cleaning and/or approved rust remover as per manufacturer protocol. Passivating / anti-corrosion coating shall be applied in specified coats over clean and dry reinforcement.

4.6 Epoxy Injection System (Low Viscosity)

Two-component low viscosity epoxy resin suitable for crack injection; compatible non-sag epoxy paste/gel for surface sealing. Injection shall be through regulated pump with pressure gauge and control.

5. Methodology - Structural RCC Section Restoration (Spalling/Corrosion Repairs)

5.1 Safety, Access and Temporary Works (Mandatory)

- Provide barricading, signage, debris nets and safe scaffolding/working platforms.
- Temporary shoring/propping/unloading is mandatory where soffit repairs are substantial, columns require large cover removal, cantilever repairs are involved, or stability during chipping is in doubt.
- Chipping shall not commence until safety and temporary works are inspected and cleared by Project Engineer.

5.2 Removal of Unsound Concrete

- Mark repair boundary beyond visible distress to include hollow/delaminated zones.
- Remove unsound concrete using light chipping tools; avoid inducing micro-cracks in sound concrete.
- Continue removal until sound concrete is achieved (visual confirmation and hammer sound).

5.3 Mandatory 360° Exposure of Corroded Bars

Expose corroded reinforcement around full circumference with clearance behind bars (typically 20-25 mm) to enable thorough cleaning and coating.

5.4 Rebar Cleaning Protocol

- Mechanical cleaning by wire brush/emery/power tools.
- Apply approved rust cleaner as per instructions; wash/neutralize if required; allow drying.
- Continue until a firm metallic surface is achieved.

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5.5 Bar Section Loss and Structural Decision Gate

After cleaning, assess bar condition:

- Minor rust/pitting: proceed with passivation and repair.
- Significant section loss, deep pitting, broken bars, inadequate anchorage or bond: stop work and obtain structural detailing for additional bars/splices/couplers/dowels or alternative strengthening measures.

5.6 Passivation / Anti-Corrosion Coating

Apply passivating/anti-corrosion coating in required coats over cleaned and dry bars, ensuring full wrap coverage.

5.7 Substrate Preparation and Bonding

Roughen substrate to expose aggregate and provide mechanical key. Remove dust; maintain SSD condition for cementitious repairs (unless epoxy bonding is specified). Apply bonding agent within open time as per datasheet.

5.8 Placement - PMRM (≤ 40 mm average thickness)

Apply PMRM in layers as per datasheet; compact around reinforcement; finish to required line/level/profile, including restoration of arrises, chamfers, drip grooves and edges as applicable.

5.9 Placement - Micro-Concrete (> 40 mm average thickness)

Provide leak-proof shuttering with tight joints and adequate supports. Provide vents/inspection points to avoid air entrapment. Place micro-concrete continuously to avoid cold joints; ensure complete encapsulation of reinforcement. Remove formwork after specified time and finish surface.

5.10 Curing and Protection

Cure cementitious repairs as per IS 456 and product datasheet (minimum 7 days unless specified otherwise). Protect repaired areas from impact/vibration during early age.

5.11 Surface Protection (When specified)

Where exposure conditions demand, provide anti-carbonation or elastomeric protective coating over repaired surfaces. For horizontal surfaces, ensure appropriate waterproofing/drainage detailing as directed.

6. Methodology - Structural Crack Repair by Low Viscosity Epoxy Injection

6.1 Applicability Check (Mandatory)

Epoxy injection shall be used only for dormant/stabilized cracks requiring structural bonding. For active cracks due to movement or continuing corrosion, arrest the cause and adopt appropriate joint/flexible treatment. Confirm substrate moisture condition and use suitable epoxy system (moisture-tolerant if approved).

6.2 Surface Preparation

Remove paint/coatings/laitance for at least 25 mm on each side of crack line. Clean with oil-free air/vacuum and ensure surface dryness as per epoxy system requirements.

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6.3 Port/Packer Installation

Select surface ports or drilled packers based on crack depth and accessibility. Determine spacing based on trials, crack width and member thickness.

6.4 Crack Sealing

Seal crack line between ports using non-sag epoxy paste/gel and allow it to cure fully before injection.

6.5 Injection, Pressure Control and Sequence (Mandatory)

Use regulated injection pump with calibrated pressure gauge. Apply the lowest pressure that achieves flow. Unless otherwise approved after trials, maximum pressure limit shall be 1.3 MPa (200 psi).

Injection sequence:

- Vertical/inclined cracks: bottom-up (lowest port first).
- Horizontal cracks: one end to the other.

Continue until refusal or epoxy appears at adjacent port; then cap and proceed sequentially. Maintain injection log.

6.6 Finishing

After curing, remove ports as required; patch port holes and make good the surface to match surrounding finish.

7. Quality Assurance, Hold Points and Records

7.1 Mandatory Hold Points (Offer for Inspection)

Section restoration:

- 1) After chipping to sound concrete and 360° bar exposure.
- 2) After rebar cleaning (before passivation).
- 3) After passivation (before closing formwork for micro-concrete).
- 4) After repair completion (before coating/painting).

Epoxy injection:

- 1) After crack mapping and port layout.
- 2) After surface prep and sealing (before injection).
- 3) During injection (pressure and sequence compliance).
- 4) After completion and finishing.

7.2 Records

- Photographic record (before/during/after).
- Product batch certificates and shelf life.
- Daily work logs.
- For epoxy injection: injection log (crack ID, port spacing, pressure range, material consumption, leakage rectification).

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8. Mode of Measurement (MoM)

8.1 Item A - Structural RCC Section Restoration by PMRM (≤ 40 mm average)

Unit: Square metre (Sqm) of finished repaired surface area.

Measure actual repaired faces: soffit/sides/edges (and top where applicable) of beams, slabs, columns, walls, etc.

Rate includes: scaffolding up to normal working height, safety arrangements, chipping/removal and disposal, 360° exposure, cleaning, rust remover, passivation, bonding agent, PMRM application, finishing, curing and complete making good.

8.2 Item B - Structural RCC Section Restoration by Micro-Concrete (> 40 mm average)

Preferred Unit: Cubic metre (Cum) of micro-concrete placed.

Volume measured as net repaired volume based on actual formed dimensions (length x width x average depth), recorded jointly.

Rate includes: all operations up to passivation and bonding; leak-proof shuttering/formwork with vents; micro-concrete placing, finishing, curing, removal of formwork, safety/scaffolding and debris disposal.

8.3 Item C - Additional Reinforcement / Dowels (when instructed)

Unit: Kilogram (Kg) of steel fixed in position including laps/couplers as approved. Drilling, cleaning of holes and chemical anchoring shall be included in this item unless provided separately.

8.4 Item D - Crack Repair by Low Viscosity Epoxy Injection

Unit: Running metre (RM) of crack repaired (centreline length on one face).

Rate includes: crack mapping, surface preparation, ports/packers, crack sealing, epoxy supply/mixing, injection with gauge control, re-injection if required, port removal, patching and making good, and scaffolding up to normal height.

9. BOQ Item Descriptions (Recommended)

BOQ Item A (Sqm): Structural RCC Section Repair with PMRM (≤ 40 mm average)

Providing and carrying out repair and rehabilitation of damaged structural RCC members (beams, slabs, columns, walls, cantilevers, stair slabs, etc.) in existing RCC having typically M15 parent concrete, affected by spalling/delamination/crumbling and exposed/corroded reinforcement, complete in all respects, including: marking of hollow zones; scaffolding/working platforms, barricading, safety nets and protection; temporary propping/unloading where required; careful chipping/removal of all unsound concrete to sound substrate; debris disposal; full 360° exposure of corroded bars with clearance; mechanical cleaning and approved rust remover treatment including wash/neutralization as applicable; assessment of bars and reporting of significant section loss; application of approved passivating/anti-corrosion coating (two coats); substrate preparation, cleaning and application of bonding agent; section restoration using polymer modified repair mortar (thixotropic) for average thickness up to 40 mm, compacted and finished to line/level/profile; curing

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as per IS 456 and product datasheet; making good complete as directed.

Unit: Sqm of finished repaired surface area.

BOQ Item B (Cum): Structural RCC Section Repair with Micro-Concrete (> 40 mm average)

Providing and carrying out deep section repair/encasement of damaged structural RCC members in existing RCC typically M15 parent concrete, where average repair thickness exceeds 40 mm, complete, including all operations described in Item A up to passivation and bonding; additionally providing leak-proof shuttering/formwork with supports and vents, sealing joints to prevent grout loss; placing approved non-shrink micro-concrete/repair concrete to fully encapsulate reinforcement without voids; finishing, curing, removal of formwork, making good, complete as directed.

Unit: Cum of micro-concrete actually placed (net repaired volume).

BOQ Item C (Kg): Additional Reinforcement / Dowels with Chemical Anchoring

Providing and fixing additional reinforcement/dowels/shear pins/anchorage bars as directed by Structural Consultant and Engineer-in-Charge, including cutting, bending, placing, binding with galvanized binding wire, drilling holes, cleaning holes, supplying and injecting approved chemical anchor adhesive, installation to required embedment, laps/couplers as approved, spacers/cover blocks, complete.

Unit: Kg of steel fixed in position.

BOQ Item D (RM): RCC Crack Repair by Low Viscosity Epoxy Injection

Providing and carrying out structural crack repair in RCC members by low viscosity epoxy pressure injection, including crack mapping and preparation; removal of coatings/laitance for adequate bond; cleaning/drying; fixing injection nipples/ports/packers at required spacing; sealing crack line with non-sag epoxy paste; mixing and injecting approved two-component low viscosity epoxy resin using calibrated pump and gauge; maintaining controlled injection pressure (maximum 1.3 MPa or 200 psi unless otherwise approved) and correct injection sequence (vertical cracks bottom-up; horizontal cracks end-to-end) until refusal/appearance at adjacent ports; capping, re-injection if required; removal/finishing of ports/seals; patching and making good complete as directed.

Unit: RM of crack repaired (one face).

10. Notes and General Conditions

- 1) All proprietary materials (repair mortars, micro-concrete, epoxy, bonding agents, passivators) shall be from approved manufacturers and used strictly as per manufacturer datasheets.
- 2) The Contractor shall conduct trial patches/injection trials where directed to finalize port spacing, pressure and workability.
- 3) Any discovery of severe reinforcement section loss, inadequate lap/anchorage, or distress beyond the defined repair scope shall be immediately reported and work shall proceed only after revised instructions from Structural Consultant.
- 4) The Contractor shall protect adjacent finishes, services and occupied areas; dust and debris control is mandatory.

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B

Specification, Methodology, Mode of Measurement and BOQ Descriptions

Repair of Damaged Non-Structural RCC Components (M15 Parent Concrete – Typical)

**For RCC Lintels, Chajjas / Sunshades, Drop-Pardi, RCC Fins,
Coping, Bands, Projections, Parapet Features and Similar
Elements**

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1. Scope and Intent

This document provides a standard specification, execution methodology, quality requirements, and a single comprehensive BOQ item for repair and reinstatement of damaged non-structural RCC architectural components suffering from concrete crumbling, delamination, spalling and exposed / corroded reinforcement.

The items include (but are not limited to):

- RCC lintels and architectural beams over openings
- RCC chajjas / sunshades / small canopies (including edge and drip portions)
- Drop-pardi and façade projections
- RCC fins, bands, cornices and façade features
- RCC coping, parapet edge elements, small ledges and similar non-structural components

Important: Where the component is behaving structurally (e.g., cantilever chajja with significant cracking/deflection or doubtful anchorage of top bars), patch repair shall not be adopted as a substitute for structural strengthening/recasting. Such cases shall be dealt with under a separate structural item as per the Structural Consultant's design.

2. Reference Standards (Codal Framework)

The work shall generally comply with the latest revisions of the following, as applicable:

- IS 456 – Plain and Reinforced Concrete – Code of Practice (durability, cover, workmanship, curing)
- IS 1786 – High strength deformed steel bars and wires for concrete reinforcement
- IS 15988 – Seismic evaluation and strengthening of existing RCC buildings (rehabilitation approach guidance)
- IS 13311 (Part 1 & Part 2) – Non-Destructive Testing of Concrete: UPV and Rebound Hammer
- IS 516 (relevant parts) – Methods of tests for strength of concrete
- IS 10262, IS 383, IS 2386 series, IS 9103 – Mix design, aggregates and admixtures (where applicable)

Where BIS is silent for proprietary repair systems, product-system acceptance may additionally be guided by recognized references such as ACI 562 / ACI 546R and EN 1504 (repair products and systems), subject to Engineer-in-Charge approval.

3. Definitions

Spalling: Detachment of cover concrete typically due to reinforcement corrosion expansion.

Delamination: Hidden separation of layers, identified by hollow sound on tapping.

Modified Mortar (PMRM): Polymer modified repair mortar, thixotropic for overhead/vertical use, typically for thin/medium build repairs.

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Micro-Concrete: Flowable / non-shrink repair concrete for deep section restoration requiring shuttering/formwork.

Parent Concrete: Existing concrete of the structure; for this document, typically assumed M15 grade in old buildings unless proven otherwise.

4. Assessment and Repair System Selection

Prior to repair, the contractor shall jointly inspect and map the distress. Hollow zones shall be identified by tapping and marked. Where directed, comparative NDT (Rebound Hammer / UPV as per IS 13311) and cover scanning may be carried out.

4.1 Selection: Modified Mortar vs Micro-Concrete

Unless otherwise directed, selection shall be as below:

- Average repair thickness up to and including 40 mm: use Polymer Modified Repair Mortar (PMRM) / modified mortar.
- Average repair thickness exceeding 40 mm: use Non-shrink Micro-Concrete / repair concrete with leak-proof shuttering/formwork.

Mandatory refinements (site practical):

- Micro-concrete shall also be adopted where reinforcement congestion or geometry makes mortar compaction unreliable, or where monolithic encapsulation is necessary.
- Modified mortar may be used for small local pockets slightly exceeding 40 mm only if the approved product permits multi-layer application without sagging, and the Engineer-in-Charge accepts it in writing.

4.2 Strength Compatibility – Typical M15 Parent Concrete

The parent concrete in many old buildings is typically M15. Repair materials shall be durable and compatible. Repair mortar / micro-concrete shall not be weaker than the parent concrete. As a minimum, the repair system shall achieve a 28-day compressive strength not less than M20 equivalent; M25–M30 equivalent is preferred for exterior projections subjected to wetting and drying, subject to product datasheet and Engineer approval.

5. Materials Requirements

5.1 Polymer Modified Repair Mortar (PMRM)

PMRM shall be suitable for overhead/vertical repairs and shall:

- Be shrinkage-controlled and thixotropic to prevent sagging.
- Have proven bond to concrete substrate; compatible with the chosen bonding agent.
- Comply with the approved manufacturer datasheet for layer thickness per pass, mixing, pot life and curing.

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5.2 Non-shrink Micro-Concrete / Repair Concrete

Micro-concrete shall:

- Be non-shrink / low shrinkage and suitable for section restoration with shuttering.
- Be flowable/placable to fully encapsulate reinforcement without voids.
- Comply with approved datasheet for formwork pressure, placing method and curing.

5.3 Reinforcement and Anchoring

Where additional reinforcement/dowels are required, steel shall be as per IS 1786 (Fe500/Fe500D or as specified). Chemical anchoring systems, if used, shall be approved systems with defined installation procedure and embedment depths.

5.4 Corrosion Treatment System

Corrosion treatment shall comprise:

- Approved rust cleaner / rust remover (as per manufacturer instructions, including wash/neutralization where applicable).
- Approved passivating/anti-corrosion coating to reinforcement after cleaning (typically 2 coats).

5.5 Protective Coating / Waterproofing

For chajjas/copings and other top horizontal surfaces, provide waterproof/protective coating system and detailing to prevent recurrence, including slope correction and drip groove restoration where applicable.

6. Execution Methodology (Method Statement)

6.1 Safety, Access, Scaffolding and Protection

- Provide barricading, warning boards, debris nets and safe access/working platform/scaffolding.
- Provide temporary propping/support where chipping may reduce section, or where cantilever projections show cracking/delamination.
- All safety measures and PPE shall be strictly followed; no work shall commence in unsafe conditions.

6.2 Removal of Unsound Concrete

- Mark the distressed boundary, extending beyond visible damage to include hollow/delaminated zones.
- Chip and remove all loose/unsound concrete carefully using light chipping tools to avoid inducing microcracks.
- Continue removal until sound concrete is reached (confirmed by hammer sound and visual inspection).

6.3 Mandatory Rebar Exposure (360-degree)

Where reinforcement is rusted/corroded, the bar shall be exposed all around (full periphery). Concrete shall be removed to provide adequate clearance behind the bar (typically 20–25 mm) so that cleaning and coating can be applied around the entire circumference.

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6.4 Rebar Cleaning and Rust Removal Protocol

Cleaning shall be executed in the following sequence:

1. Mechanical pre-cleaning using wire brush / emery paper / suitable power tools to remove loose rust scale.
2. Apply approved rust cleaner as per manufacturer's instructions (dwell time, agitation, and wash/neutralization as applicable). Allow the bar to dry.
3. If rust remains, continue mechanical cleaning using wire brush / abrasive paper until firm metal surface is obtained.
4. For heavy corrosion/pitting or stubborn scale, perform gentle heating with gas flame, subject to site safety and approvals.

6.5 Assessment of Bar Section Loss and Additional Bars (if required)

After cleaning, reinforcement shall be checked for section loss and continuity. If significant section loss, deep pitting, or compromised anchorage is observed, provide additional reinforcement/dowels with adequate development length and anchorage as per IS 456 detailing principles, or shift to recasting/strengthening as directed by the Structural Consultant.

6.6 Passivation / Anti-corrosion Coating to Reinforcement

Apply approved passivating/anti-corrosion coating over cleaned and dry reinforcement, fully wrapping the bar circumference. Follow manufacturer's coverage rate, number of coats and recoat time.

6.7 Substrate Preparation and Bonding

- Roughen the concrete substrate to obtain mechanical key; remove dust and contaminants.
- Pre-wet substrate to SSD condition before cementitious repairs (unless epoxy bonding is specified).
- Apply approved bonding agent (polymer bonding slurry or epoxy) immediately prior to placing repair mortar/micro-concrete, within its open time.

6.8 Placement of Repair Material

A) Polymer Modified Repair Mortar (PMRM) – up to 40 mm average thickness:

- Apply PMRM in layers within the approved maximum thickness per pass; compact properly around reinforcement.
- Finish the surface to line/level and reinstate architectural profile (chamfers, edges, drip grooves) as applicable.

B) Micro-Concrete – more than 40 mm average thickness:

- Provide leak-proof shuttering/formwork with adequate supports; seal joints to prevent grout loss.
- Provide vents/inspection points where necessary to avoid air entrapment.
- Place micro-concrete continuously and ensure full encapsulation of bars; avoid cold joints.
- Remove formwork after specified time and complete finishing.

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6.9 Curing and Protection

Curing shall be carried out as per IS 456 and product requirements. Minimum curing period shall be 7 days for cementitious systems, or as per approved datasheet, whichever is more stringent. Protect repaired surfaces from vibration/impact during early age.

6.10 Preventive Detailing (Mandatory for Exterior Projections)

- Ensure positive outward slope on top surfaces of chajjas/copings/bands to prevent ponding.
- Provide/restore drip groove at the free edge underside where applicable.
- Seal junctions with wall/beam and apply waterproof/protective coating system on top surfaces.
- Apply final exterior protective coating (anti-carbonation/elastomeric) on repaired faces as directed.

7. Quality Assurance, Inspection Hold Points and Acceptance

The contractor shall maintain QA/QC records including photographs, material batch certificates, and daily work logs. The following hold points shall be offered for inspection:

After chipping/removal to sound concrete and full 360-degree exposure of corroded reinforcement.

After completion of rust cleaning (including rust cleaner and blasting where required) and before application of passivating coating.

After coating and before closing shuttering/formwork (where micro-concrete is used).

After completion of repair and before application of waterproofing/protective coatings/painting.

Acceptance shall be based on visual finish (no hollowness/loose patches), proper profile restoration, absence of significant shrinkage cracking, and compliance with approved repair system datasheets and engineer's instructions.

8. BOQ – Single Comprehensive Item (Inclusive)

Item: Repair and rehabilitation of damaged non-structural RCC components (lintels, chajjas/sunshades, drop-pardi, RCC fins, coping, façade bands, projections, parapet features and similar elements) affected by crumbling/spalling concrete and corrosion of reinforcement, complete in all respects, including the following:

- All scaffolding/working platforms, barricading, safety nets, protection, and temporary propping/support where required.
- Identification/marketing of delaminated zones; careful chipping/removal of unsound concrete to sound substrate; disposal of debris.
- Full 360-degree exposure of corroded reinforcement with adequate clearance behind bars for cleaning and coating.
- Mechanical cleaning (wire brush/emery/power tools), application of rust cleaner, washing/neutralization (as applicable), and abrasive blasting (e.g., 60/90 mesh garnet or equivalent) where required.
- Assessment of bar condition; providing and fixing additional reinforcement/dowels with approved chemical anchoring where directed; GI binding wire and spacers/cover blocks.

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- Application of passivating/anti-corrosion coating to reinforcement; substrate preparation and bonding agent application.
- Section restoration using polymer modified repair mortar (for up to 40 mm average thickness) and/or non-shrink micro-concrete (for more than 40 mm average thickness) including all shuttering/formwork for micro-concrete.
- Finishing to line/level including drip groove/chamfer/profile restoration; curing; waterproofing/protective coatings and final exterior protective coating/painting as directed.
- Submission of QA/QC documentation with photographs and material batch certificates.

Unit of Measurement: Square metre (Sqm) of finished repaired surface area.

9. Mode of Measurement (Single Item)

Measurement shall be in Sqm of the finished repaired surface area of the RCC component (measured on the faces actually repaired: soffit/sides/top as applicable).

The quoted rate shall be deemed inclusive of all materials, labour, tools, tackles, access, scaffolding, safety, propping, formwork/shuttering, curing, surface protection, disposal, and all leads/lifts, as described under the single BOQ item.

Average repair thickness shall be recorded in site measurement book (for control and method selection only). No separate payment shall be made for thickness variations within this item.

Cases requiring structural strengthening or complete recasting due to structural inadequacy (e.g., excessive deflection, anchorage failure, major section loss) shall be executed only under a separate approved item and measured separately.

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Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

C

SPECIFICATION, METHODOLOGY AND MODE OF MEASUREMENTWITH BOQ DISCRPTION FOR RCC MEMBER CRACK REPAIR BY LOW VISCOSITY EPOXY INJECTION GROUTING

Manish V. Doshi	Repair, Strengthening & Facelifting Specifications
Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

1.0 Scope

1.1 This specification covers repair of cracks in Reinforced Cement Concrete (RCC) members (beams, slabs, columns, walls, foundations, etc.) by pressure injection of LOW VISCOSITY EPOXY resin system to restore monolithic action, improve structural integrity and reduce moisture ingress.

1.2 Work includes inspection and marking of cracks, surface preparation, drilling where required, fixing of injection nipples/ports (surface mounted or socket/packer type), sealing of crack line, mixing and injection of epoxy, sequential port operation (nipple sequence), pressure control with gauge, removal/finishing of ports and seals, cleaning, and making good the surface complete as directed by Engineer-in-Charge (EIC).

1.3 This item is intended for dormant/stabilized cracks where structural bonding is required. For moving/active cracks, joints/movement detailing or flexible sealing systems shall be adopted; epoxy injection alone is generally not suitable.

2.0 References (Latest Editions)

- a) RDSO BS-133: Guidelines for Repair of Concrete & Masonry Structures (Indian Railways) – section on Epoxy Injection and related repair methods.
- b) ACI 224.1R: Causes, Evaluation, and Repair of Cracks in Concrete Structures – guidance on epoxy injection, sequencing and pressure selection.
- c) ACI RAP-1: Structural Crack Repair by Epoxy Injection – guidance on material viscosity selection, port spacing, injection procedure and pressure management.
- d) ASTM C881: Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete (for epoxy classification / selection) (as referenced by ACI RAP-1).
- e) IS 456: Plain and Reinforced Concrete – general requirements for concrete workmanship, durability, cleaning and water quality.

3.0 Definitions and Applicability

3.1 Dormant crack: Crack that is stable and not subject to ongoing movement. Epoxy injection may be adopted to restore structural continuity.

3.2 Active crack: Crack that is still moving due to settlement, thermal/shrinkage movement, vibration, overloading, corrosion expansion, etc. Epoxy injection may not be appropriate unless the movement is arrested and the crack is treated as a joint where required.

3.3 Suitability checks (mandatory):

- Confirm crack cause and whether crack is dormant.
- Epoxy injection is NOT recommended for cracks caused by ongoing reinforcement corrosion (continuing corrosion will create new cracks).
- Crack must be sufficiently dry for moisture-sensitive epoxies; if damp and cannot be dried, use moisture-tolerant epoxy system as approved.

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- Actively leaking cracks shall not be injected with typical epoxies unless leakage is stopped and substrate dried (or a suitable moisture tolerant system is approved).

4.0 Materials

4.1 Epoxy injection resin system:

- Two-component low viscosity epoxy resin suitable for crack injection, selected to match crack width, member thickness and access.
- For very fine cracks (about 0.3 mm and smaller), use low-viscosity epoxy (typically 500 cps or less) as per ACI RAP-1 guidance.
- Epoxy shall conform to relevant grade/type requirements of ASTM C881 as applicable (selection to be approved by EIC).
- Manufacturer's product data sheet (PDS), method statement and safety data sheet (SDS/MSDS) shall be submitted and approved before use.

4.2 Seal / cap material:

Non-sag epoxy paste/gel or other compatible proprietary cap seal material to seal the crack line and bond nipples/ports, capable of sustaining injection pressures.

4.3 Cleaning materials:

Oil-free compressed air, clean water, suitable solvents/cleaners compatible with epoxy system as per manufacturer, and abrasive tools as required.

4.4 Prohibited:

- Use of expired or shelf-life exceeded epoxy.
- Unapproved mixing ratios, field dilution, or addition of fillers not recommended by manufacturer.
- Injection into actively leaking cracks without approved moisture tolerant system and control measures.

5.0 Equipment

- Epoxy injection pump suitable for low-viscosity resin (hand, pneumatic or electric), with pressure regulator and calibrated pressure gauge.
- Injection nipples/ports: surface-mounted ports, socket-mounted ports, or mechanical packers as appropriate.
- Rotary drill with suitable bits, wire brushes, grinders, scrapers.
- Mixing containers, graduated measuring jars, low-speed mixer/paddle.
- Oil-free compressed air blower/vacuum; PPE and ventilation arrangements.

6.0 Methodology (Execution Procedure)

6.1 Pre-investigation and marking

- Identify and map all cracks on drawings/photographs. Mark crack line and note crack width variation, orientation (vertical/horizontal/inclined), member type and access (one-side or two-side access).

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- b) Carry out crack monitoring where directed to confirm dormancy.
- c) Confirm that crack cause is addressed (e.g., overload removal, settlement stabilization, waterproofing/drainage correction, etc.).
- d) Agree repair objective with EIC: structural bonding, waterproofing, or both.

6.2 Surface preparation

- a) Remove paint, laitance, coatings, weak concrete, dirt and contaminants along a strip at least 25 mm on each side of the crack (or as required for cap seal bond).
- b) Clean crack line by oil-free compressed air/vacuum; if water cleaning is used, allow adequate drying (or use moisture tolerant epoxy approved for damp substrate).
- c) Where adjacent concrete is deteriorated, V-groove until sound concrete is reached to provide a firm cap seal base.

6.3 Nipple / port layout and installation

- a) Port spacing shall be finalised through trial and as per crack width and member thickness. As a general guide, closer spacing is used for finer cracks; spacing may be increased for wider cracks.
- b) Two common port types:
- Surface-mounted ports bonded over the crack line.
 - Socket-mounted ports/packers fixed into drilled holes intersecting the crack plane (used where cracks are blocked or to improve penetration).
- c) Install ports after surface is properly prepared. Ensure ports are securely bonded/fixed and aligned for hose connection.
- d) Provide venting/bleed points where required (particularly for long horizontal cracks and complex geometry).

6.4 Sealing (cap seal)

- a) Seal the crack on the surface between ports using non-sag epoxy paste/gel to prevent leakage during injection.
- b) Ensure cap seal is continuous and adequately thick (typical band about 25 mm wide) and fully cured before injection, so it can resist injection pressures.
- c) If temperature changes cause cap seal cracking before injection, repair the cap seal prior to injection.

6.5 Mixing of epoxy

- a) Mix components strictly as per manufacturer's specified ratio, using measured quantities.
- b) Mix only such quantity that can be placed within the pot life. Do not use epoxy that has started gelling.
- c) Maintain correct ambient temperature range as per manufacturer; provide ventilation in closed spaces.

6.6 Injection procedure, pressure control and nipple sequence (mandatory)

- a) General:
- Start injection only after cap seal and port bonding adhesive have cured and can sustain injection pressures.
 - Use a calibrated pressure gauge and regulator; maintain steady controlled injection.

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- The pressure used for injection shall be selected carefully; excessive pressure can propagate existing cracks and cause additional damage.

b) Injection pressure:

- Use the lowest pressure that achieves consistent flow and penetration.
- If epoxy does not flow, pressure may be increased carefully in steps. As per ACI RAP-1, increased pressure of approximately 200 psi (about 1.3 MPa) may be used for narrow cracks for short duration (about 5 minutes) with careful control to avoid blowout of cap seal/ports.
- Under no circumstance shall pressure be increased to a level that causes leakage, cap seal blowout, or cracking/sounding distress. Maximum pressure shall be limited to 1.3 MPa (200 psi) unless specifically approved in writing by EIC based on trials and member condition.

c) Nipple / port sequence (to be followed):

i) Vertical or inclined cracks: Begin injection at the LOWEST elevation port. Pump epoxy until epoxy reaches the next predetermined port above (observed by epoxy discharge/appearance). Cap/close the lower port immediately, then inject at the next higher port. Repeat progressively upward until the entire crack is filled and all ports are capped.

ii) Horizontal cracks: Proceed from ONE END of the crack to the other in a similar manner. Where crack width varies significantly, injection may start at the widest segment/end as directed, but the sequence shall always be systematic to ensure complete filling.

iii) Overhead/slab cracks: Start from one end/lowest point (or widest segment where directed) and proceed sequentially to avoid air entrapment.

iv) Completion/refusal: Injection at a port is considered complete when refusal is achieved or when the epoxy appears at the adjacent port and pressure can be maintained. If pressure cannot be maintained, epoxy is still flowing into unfilled portions or leaking; identify leakage and reseal before continuing.

v) Re-injection: Where required by EIC, re-inject after initial set in stages for long/complex cracks until stable refusal is achieved (subject to crack behavior and leakage control).

6.7 Finishing, removal and making good

a) After epoxy has cured, remove injection nipples/ports and cap seal by chipping/grinding if required (or leave in place if appearance is acceptable and EIC approves).

b) Patch port holes and surface defects with compatible repair mortar/epoxy mortar as approved.

c) Reinstall protective coating/finish where included in scope.

7.0 Quality Assurance / Acceptance

7.1 Hold points for inspection and approval by EIC:

- After crack mapping and repair proposal.
- After surface preparation and port layout.
- After sealing and prior to injection.
- During injection for pressure and sequence compliance.
- After completion and finishing.

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7.2 Records / grout log to be maintained:

Crack ID, member/location, crack width range, port type and spacing, epoxy batch/lot no., mixing time, ambient temperature, injection start/stop time, pressure range used, sequence followed, consumption, leakage points and rectification, final remarks.

7.3 Verification:

Where specified, take cores to verify epoxy penetration and visually inspect core for continuity; patch core holes with compatible grout/mortar.

7.4 Acceptance criteria:

- No uncontrolled leakage during injection.
- Sequential filling observed at adjacent ports as expected.
- No new crack propagation or distress induced by injection.
- Surface made good and finish restored as specified.

8.0 Mode of Measurement (MoM)

Unit: Running Metre (RM) of crack repaired.

Measurement shall be along the centreline of crack on the exposed face (one face), as directed, irrespective of number of nipples/ports required.

Rate shall include:

- Crack mapping/marking, surface preparation, cleaning/drying.
- Supply and fixing of nipples/ports/packers, sealing/cap seal.
- Supply, mixing and injection of low viscosity epoxy with all consumables.
- Pressure control with gauge, sequential nipple operation, capping.
- Removal/finishing of ports and seals, patching/making good.
- All labour, tools, tackles, scaffolding up to normal working height, safety arrangements and disposal complete.

No separate payment shall be made for number of nipples/ports, trials, wastage, re-injection, or stoppages due to leakage unless BOQ provides separate items.

9.0 BOQ Item Description

Providing and carrying out structural crack repair in RCC members by LOW VISCOSITY EPOXY pressure injection, including crack mapping and preparation, removal of coatings/weak surface for adequate bond, cleaning and drying, fixing injection nipples/ports (surface or socket mounted) at required spacing, sealing/cap sealing of crack line with non-sag epoxy paste, mixing and injecting two-component low viscosity epoxy resin as per manufacturer and as per approved procedure, maintaining controlled injection pressure with gauge (maximum 1.3 MPa / 200 psi unless otherwise approved), injecting in proper sequence (vertical cracks bottom-up; horizontal cracks end-to-end) until refusal/appearance at adjacent ports, capping ports, removal/finishing of ports and seal, patching and making good, complete as per

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specifications and as directed by Engineer-in-Charge.

Unit: RM

Note: For cracks that are active/moving or caused by continuing reinforcement corrosion, epoxy injection shall not be adopted unless specifically directed with additional measures under separate items.

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D

SPECIFICATION, METHODOLOGY, MODE OF MEASUREMENT & BOQ DESCRIPTION

Cementitious (Non-Epoxy) Pressure / Injection Grouting for Masonry Cracks

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Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

1.0 Scope

1.1 This work covers structural crack repair in masonry by pressure injection of cementitious grout (non-epoxy) to restore continuity and integrity of cracked masonry, including all associated surface preparation, drilling, fixing injection ports/packers, sealing, injection, finishing and curing.

1.2 This technique is applicable for masonry buildings and construction; crack repair by grout injection is specifically described in IS 13935.

1.3 Epoxy / resin-based injection/grouting materials are NOT permitted under this item.

2.0 Reference Standards (latest editions wherever applicable)

IS 13935 – Seismic evaluation, repair and strengthening of masonry buildings – Guidelines (repair by pressure injection of cement grout).

IS 1905 – Structural use of unreinforced masonry (general masonry provisions).

IS 2250 – Preparation and use of masonry mortars (for sealing/repointing mortars etc.).

IS 456 – Water quality for mixing/curing (water shall be clean, potable preferable).

IS 9103 – Concrete admixtures (for non-shrink / plasticizing admixtures where used).

3.0 Pre-conditions (mandatory engineering checks)

3.1 Crack cause assessment: Before grouting, the Engineer-in-Charge (EIC) shall confirm whether cracks are active (progressive) or dormant.

If cracks are active due to settlement, vibration, moisture movement, thermal effects, overloading, etc., the root cause shall be arrested first; otherwise re-cracking is likely.

3.2 Crack classification for this item (based on IS 13935 guidance):

0.5 mm to 5 mm: treat by pressure injection grout.

> 5 mm or crushed/loose masonry: do not rely only on injection; open up, remove loose material, rebuild/repoint and then grout if required.

3.3 Any requirement of additional strengthening (stitching, bands, jacketing, ties, etc.) shall be covered under separate items.

4.0 Materials (NON-EPOXY)

4.1 Cementitious grout (approved type)

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A) Microfine / ultrafine cement grout (recommended for finer cracks) or neat cement grout for normal cracks, designed through site trials to ensure penetrability and minimal bleeding.

B) Non-shrink / expansive grout additive and/or plasticizer/superplasticizer may be used only if cementitious and compliant with IS 9103 principles/requirements (no epoxy).

C) Polymer cement grout (SBR/acrylic latex modified) is acceptable only as cement-polymer grout, consistent with IS 13935 crack injection approach; epoxy polymers are prohibited.

4.2 Water

Water used for grout mixing, flushing and curing shall be clean and suitable as per IS 456 (potable preferred).

4.3 Sealing/patching mortar

Cement mortar 1:3 (cement:sand) prepared as per good practice and IS 2250, or approved polymer-modified cement mortar for sealing around ports.

No epoxy putty / epoxy sealant.

5.0 Equipment

Rotary/rotary percussion drill with suitable bits.

Injection ports/packers/nipples (GI/PVC) with non-return arrangement.

Hand / electric grout pump with pressure gauge (recommended gauge range 0–10 bar), regulating valve, hoses.

Air compressor / water jet for flushing.

Measuring jar, weighing balance, grout mixer (slow speed), sieve/strainer.

Scaffolding, PPE, cleaning tools.

6.0 Methodology (Execution Procedure)

6.1 Surface preparation & crack readiness

a) Mark crack lines on both faces wherever accessible; remove loose plaster/paint in a strip min 75–100 mm wide along crack.

b) Rake joints locally along crack where needed to expose entry path.

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c) Clean crack surfaces; remove dust/loose particles using compressed air and/or water flushing. (IS 13935 requires cleaning before injection.)

d) Pre-wet masonry (SSD condition) prior to injection to avoid grout water loss and blockage.

6.2 Drilling & port fixing

a) Drill holes to intersect the crack plane (typically 45° to wall face) at staggered spacing.

b) Injection port spacing: As per IS 13935 guidance, port c/c spacing may be taken approximately equal to thickness of the wall element (adjust after trials).

c) Fix ports/packers firmly; seal around ports and along crack surface using 1:3 cement mortar (or approved cementitious sealing compound). Allow sealing to set.

6.3 Grout trial & mix control (mandatory)

a) Conduct trial injection panel (or trial zone) to finalize: grout type, w/c ratio, admixture dosage, injection pressure range (including maximum allowable pressure), and port spacing.

b) Grout shall be mixed in measured quantities to produce a lump-free, stable slurry; strain grout through sieve/mesh if required.

6.4 Injection / pressure grouting operation

a) Start injection from the lowest port for vertical cracks, or from one end for horizontal cracks, as per IS 13935.

b) Inject grout slowly until grout is observed at the adjacent/next port (or opposite face corresponding port), then close the current port and shift sequentially.

c) Injection pressure control: Injection pressure shall be maintained at controlled low pressure adequate for penetration without lifting/bulging masonry. Unless otherwise established by approved trial, begin injection at about 1 bar (0.1 MPa) and increase gradually as required; typical working pressure may be 1–4 bar (0.1–0.4 MPa). Maximum injection pressure shall not exceed 5 bar (0.5 MPa) unless specifically approved by EIC based on trial results and masonry condition.

d) Continue until refusal (no further intake) and steady grout return is observed at vents/adjacent ports.

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e) Re-inject after initial set if specified by EIC where settlement/voids are suspected (only after checking no distress).

6.5 Finishing & curing

- a) After grout achieves initial set, remove ports (if removable) and patch holes with matching mortar.
- b) Repoint joints / reinstate plaster finish where included in scope.
- c) Cure repaired surfaces for minimum 7 days (or as directed).

7.0 Quality Assurance / Acceptance Criteria

7.1 Hold points (EIC approval required):

After surface preparation and drilling layout.

After port fixing and sealing.

After trial grout approval (mix + pressure).

7.2 Records: Daily log to include crack ID, location, approximate width category, port spacing, grout mix, injection pressure range (start/working/max), grout consumption, refusal points and observations.

7.3 Acceptance:

No leakage during injection (except controlled venting).

Cracks show grout fill/return at adjacent ports as expected.

No new cracking/bulging induced by injection.

Finish restored neatly and cured.

8.0 Mode of Measurement (MoM)

Unit: Running Metre (RM) of crack treated, measured along the centreline of crack on one face, as directed.

Measurement shall include:

Removing local plaster/finish strip (if specified as included), cleaning, flushing.

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Drilling, supplying/fixing packers/ports/nipples, sealing the crack/ports.

Mixing and injecting approved cementitious (non-epoxy) grout, including all admixtures.

Pumping with gauges, control valves, shifting sequence, pressure control, refusal operation.

Removing ports (if applicable), closing holes, curing, scaffolding up to normal working height (unless specified separately), debris disposal, complete.

No separate payment for grout quantity consumed, trial mixes, or re-injection, unless BOQ specifically provides.

Note: Industry BoQ practice for crack filling/grouting is frequently kept in RM/SQM items with routing, nipples and cement slurry/admixture included in the rate.

9.0 BOQ Item Description

Item 9 — Injection grouting of masonry cracks (0.5 to 5 mm)

Providing and carrying out cementitious pressure injection grouting for structural repair of cracks in brick/stone/block masonry of width 0.5 mm to 5 mm, using approved non-shrink cementitious grout / cement-polymer grout (NON-EPOXY), including removal of local finishes as required, cleaning/flushing, drilling holes to intersect cracks, fixing injection ports/packers, sealing of crack line and ports with cement mortar, injection from lowest port/end sequentially till grout appears at adjacent/next port/opposite face, controlled pressure pumping with gauge and within specified pressure limits, closing ports, finishing/patching of holes, curing, all labour, materials, tools, tackles, scaffolding, disposal, complete as per specifications and as directed by Engineer-in-Charge.

Unit: RM

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E

SPECIFICATION, METHODOLOGY, MODE OF MEASUREMENT & BOQ DESCRIPTION CRACK STITCHING SPECIFICATION Masonry Walls

Manish V. Doshi	Repair, Strengthening & Facelifting Specifications
Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

0. Purpose and Performance Intent

This specification covers crack stitching to existing masonry walls using CRS Fe500 C-clamps (8 mm or 10 mm dia) anchored into masonry and made composite with a subsequent guniting layer (mesh plus gunite skin). The intent is to restore local continuity across cracks, provide mechanical interlock, and control further propagation of dormant cracks.

- No chasing or groove cutting is required in masonry for this system; fixing shall be by drilling and chemical anchorage.
- Crack stitching is a repair measure. Root cause (settlement, leakage, vibration, thermal movement, overloading, etc.) shall be identified and arrested prior to repair.
- For active/moving cracks, provide movement detailing and/or suitable flexible crack treatment as directed by the Structural Consultant.

1. Codes, Standards and References (Latest Revisions as Applicable)

The work shall conform to the following standards and project drawings/specifications, as applicable:

Reference	Title / Relevance
IS 1905	Structural use of unreinforced masonry - provisions relevant to masonry integrity and workmanship
SP 20	Handbook on masonry design and construction - guidance for good masonry practices
IS 9012	Recommended practice for shotcreting (guniting) - execution and quality control
ACI 506R (Reference)	Guide to shotcrete - additional execution and QA/QC guidance (international reference)
IS 1786	High strength deformed steel bars/wires for concrete reinforcement - Fe500 grade requirements
IS 456	Plain and reinforced concrete - durability/workmanship principles applicable to gunite concrete
IS 15988 (If applicable)	Seismic evaluation and strengthening of existing buildings - overall retrofit philosophy where relevant

2. Definitions

- C-clamp stitch: A C-shaped CRS Fe500 bar installed across a crack, with two embedded legs anchored into masonry and a crown bridging the crack, subsequently encased within guniting.

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- Dormant crack: Crack not showing progressive movement during observation/monitoring.
- Active crack: Crack showing movement; requires cause removal and movement detailing prior to or instead of stitching.

3. Materials

3.1 Stitching Bars

CRS reinforcement bars of Fe500 grade, 8 mm or 10 mm dia, conforming to IS 1786, with manufacturer test certificates. Bars shall be free from oil/grease and loose rust.

3.2 Chemical Anchorage System

Approved chemical anchoring adhesive (epoxy/vinylester/hybrid) suitable for masonry substrates, non-sag, and installed strictly as per manufacturer's data (hole cleaning, injection method, curing time, temperature limits). Expired material shall not be used.

3.3 Accessories

- GI binding wire of suitable gauge for tying clamps to guniting mesh.
- Oil-free compressed air, hole-cleaning brushes, drilling consumables.
- Anti-corrosion coating on exposed steel prior to guniting where specified for aggressive exposure.

4. Design and Detailing Requirements (Minimum)

Final arrangement shall be as per Structural Consultant's crack-wise detailing based on crack pattern, wall thickness, and load path. Unless specified otherwise, the following minimum requirements apply:

4.1 Clamp Geometry

- C-clamps shall be fabricated with smooth bend radius; sharp kinks are not permitted.
- Crown shall bridge the crack with adequate overlap to develop anchorage in sound masonry on both sides.

4.2 Spacing and Extent

- Standard spacing along crack: 300 mm c/c (tighten to 200 mm c/c in severe/localised zones; relax up to 450 mm c/c only with approval).
- Provide stitching for full visible crack length plus minimum 300 mm beyond crack termination at both ends.

4.3 Anchorage Embedment (Each Leg)

- Minimum embedment depth (each leg): 8 mm bar - 100 mm; 10 mm bar - 120 mm, or as required by adhesive manufacturer/consultant, whichever is higher.
- Embedment shall not compromise back-face integrity; where thickness does not permit the above, detailing shall be revised by the consultant (alternate anchorage/diameter/through-tie strategy).

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4.4 Hole Diameter and Location

- Hole diameter typically bar dia + 4 to 6 mm (or as per chemical anchor manufacturer).
- Clamp legs generally 75 to 100 mm away from crack line on each side, subject to masonry condition and wall thickness.
- Maintain minimum edge distance from free edges/openings (typically ≥ 75 mm) and avoid drilling into weak/voided masonry pockets.

4.5 Integration with Guniting Reinforcement

- Clamps shall be positioned to ensure full embedment within gunite with cover consistent with guniting specification and exposure conditions.
- Clamps shall be mechanically tied to guniting mesh as required to prevent displacement during spraying and to ensure composite action.
- Where guniting is provided on both faces, arrangement shall be detailed to avoid eccentric load transfer.

5. Methodology / Execution (No Chasing in Masonry)

5.1 Pre-Works (Hold Point 1)

5. Prepare crack map and mark full extents. Confirm dormant/active status as directed (tell-tales/monitoring if required).
6. Ensure sources of leakage/dampness are controlled prior to chemical anchorage work.

5.2 Surface Preparation

7. Remove loose plaster/paint and unsound mortar in the repair zone to expose sound substrate.
8. Clean the surface and remove dust using brush and oil-free compressed air.

5.3 Setting Out

9. Mark C-clamp locations at specified spacing along the crack.
10. Mark drilling points ensuring adequate edge distance and avoiding openings/services.

5.4 Drilling and Hole Cleaning (Hold Point 2)

11. Drill holes to required diameter and embedment depth using suitable rotary hammer/drill.
12. Clean each hole strictly as per anchor system procedure: blow out, brush, blow out (repeat until dust free).
13. Ensure hole condition (dry/moist) complies with adhesive manufacturer requirements.

5.5 Fixing C-Clamps with Chemical Adhesive (Hold Point 3)

14. Fabricate C-clamps to correct geometry and leg length.
15. Inject chemical adhesive into each hole as per manufacturer instructions (nozzle mixing and fill quantity).
16. Insert clamp legs with slow twisting motion to ensure full wetting and avoid voids; align crown to bridge the crack correctly.
17. Remove excess adhesive; allow full curing time as per datasheet prior to mesh fixing/guniting.

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5.6 Mesh Fixing and Guniting Embedment

18. Fix reinforcement mesh for guniting as per approved guniting specification and project drawings.
19. Tie clamps to mesh where required using GI binding wire to prevent movement during spraying.
20. Execute guniting in accordance with IS 9012 and approved method statement, ensuring full embedment of clamps and avoidance of shadowing/voids; control rebound and ensure proper compaction.
21. Cure and protect gunite as specified.

6. Inspection, QA/QC and Acceptance

6.1 Submittals and Records

- CRS Fe500 bar mill certificates and chemical anchor product datasheets with batch/expiry records.
- Installation log: crack ID/location, length, clamp dia, spacing, hole dia/depth, adhesive batch, curing time, and inspection sign-off at hold points.

6.2 Minimum Site Checks

- Verify clamp spacing, embedment depth and edge distances prior to adhesive injection.
- Verify hole cleaning sequence compliance.
- Verify adhesive mixing/injection method and curing time based on site temperature.
- Verify clamps are not loose and are secured prior to guniting.

6.3 Proof/Pull Tests (If Directed)

Random proof tests on representative anchors/clamps may be carried out as directed to validate bond performance.

6.4 Acceptance Criteria

- No clamp exposure after guniting; adequate cover achieved as per guniting specification.
- No hollow sound/void indications around clamp zones in finished gunite.
- Correct spacing and crack coverage achieved as per drawings and this specification.

7. Safety and Environmental Requirements

- Dust control during drilling; PPE including eye/ear/respiratory protection.
- Chemical handling in accordance with MSDS: gloves, goggles, ventilation and spill control.
- Working at height: scaffold safety, barricading and fall protection as applicable.
- Dispose debris and empty chemical cartridges as per site environmental requirements.

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8. Mode of Measurement (MoM) and Payment

8.1 Preferred Measurement (Recommended)

Unit: Number (Nos.) of C-clamps installed. This is recommended to avoid disputes due to variable crack densities and site-driven spacing adjustments.

8.2 Alternate Measurement (If BOQ is in Running Metre)

Unit: Running metre (Rmt) of crack stitched, measured along crack centreline. The BOQ shall clearly state the assumed clamp spacing (e.g., 300 mm c/c) included in the rate; any deviation instructed on site shall be measured/paid as per agreed adjustment notes.

8.3 Rate to Include (Unless Stated Otherwise)

- Surface preparation in repair zone; drilling, hole cleaning and anchorage installation.
- Supply/fabrication/installation of CRS Fe500 C-clamps (8/10 mm) including chemical adhesive.
- Tying to guniting mesh using GI binding wire as required.
- Tools, consumables, scaffolding up to normal working height, protection and disposal of debris.
- Note: Guniting and reinforcement mesh are generally measured under separate BOQ items unless expressly combined.

9. BOQ Item Description

Providing crack stitching to masonry walls using CRS Fe500 reinforcement C-clamps (8 mm / 10 mm dia) across cracks without chasing, by drilling holes on both sides of crack, thorough hole cleaning, chemical anchoring of clamp legs using approved adhesive, and securing clamps to subsequent guniting reinforcement mesh to ensure full embedment within guniting, including all labour, materials, tools, consumables, scaffolding and disposal of debris complete as per drawings, specifications and Engineer-in-Charge/Structural Consultant direction. Measurement: (a) Nos. of C-clamps installed, or (b) Running metre of crack stitched as specified in BOQ.

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Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

F

SPECIFICATION, METHODOLOGY, MODE OF MEASUREMENT & BOQ DESCRIPTION

GUNITING (SHOTCRETE) OVER EXISTING MASONRY WALLS (INTERNAL & EXTERNAL FACES) FOR GRAVITY LOAD & SEISMIC RESISTANCE STRENGTHENING

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Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

1. SCOPE

1.1 This work comprises strengthening of existing masonry load-bearing walls by providing cement mortar gunite (shotcrete) jacketing on both internal and external faces of the walls, including all preparatory and incidental works necessary to achieve durable bonding and improved seismic and gravity load performance.

1.2 The scope of work includes:

- Removal of existing plaster, finishes, and loose materials from wall surfaces.
- Repair or reconstruction of disturbed or defective masonry, including raking and repointing of joints.
- Supply and fixing of galvanized welded wire mesh of size 50 mm × 50 mm using 3 mm diameter wire.
- Mechanical anchorage of mesh and gunite jacket to masonry as well as RCC members (RCC vertical stiffener columns and RCC lintel band).
- Application of 40 mm thick cement mortar gunite in the proportion 1:3 (cement:sand).
- Proper curing, surface protection, housekeeping, and disposal of debris.
- Provision of scaffolding, barricading, and all safety arrangements for internal and external works.

1.3 Execution restriction: Guniting shall be carried out strictly one face at a time (either internal or external) to avoid instability, excessive moisture ingress, and uncontrolled stress redistribution in weak masonry.

1.4 Through-ties: Through-ties connecting internal and external gunite jackets shall be provided only at parapet level, at 900 mm c/c, located at mid-height of the parapet, as specified in Clause 7.6.

2. REFERENCE STANDARDS

The work shall comply with the latest revisions of the following Indian Standards:

- IS 13645 – Guniting over masonry surfaces.
- IS 9012 – Recommended practice for shotcreting.
- IS 13935 – Repair and seismic strengthening of buildings.
- IS 456 – Plain and reinforced concrete.
- IS 383 – Aggregates.
- IS 269 / IS 8112 / IS 12269 – Ordinary Portland Cement.
- IS 9103 – Concrete admixtures (if used).
- IS 1893 (Part 1): 2016 – Criteria for earthquake resistant design of structures.

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Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

3. MATERIALS

3.1 Cement: Ordinary Portland Cement (OPC) 43 or 53 grade conforming to relevant IS standards, fresh and from approved manufacturers.

3.2 Sand: Clean, hard, well-graded sand conforming to IS 383, with maximum particle size 4.75 mm, free from silt, clay, and organic impurities.

3.3 Water: Clean potable water conforming to IS 456.

3.4 Welded Wire Mesh:

- Galvanized welded wire mesh.
- Wire diameter: 3 mm.
- Mesh size: 50 mm × 50 mm.
- Welds intact at all intersections; mesh free from oil, grease, rust, or damage.

3.5 Binding Wire:

- All binding wires used for mesh laps, anchorage, and tying to dowels shall be galvanized iron (GI) binding wire of adequate thickness (minimum 16 gauge or as approved) to ensure durability and corrosion resistance.

3.6 Fixings and Anchors to Masonry:

- Mild steel pins, anchors, or bolts (6–8 mm dia) with adequate embedment.
- Anchors shall be staggered to avoid splitting masonry.

3.7 Anchors/Dowels to RCC Members:

- Chemical anchors or dowels, typically 8 mm diameter, fixed into RCC stiffener columns and lintel band.
- Minimum embedment as per manufacturer's recommendation (generally not less than 100 mm).
- Only approved epoxy/chemical anchoring systems shall be used.

3.8 Gunit Mortar:

- Cement mortar in the proportion 1:3 (cement:sand).
- Water content controlled at nozzle to produce dense, cohesive mortar with minimal rebound.
- No chloride-based admixtures shall be permitted.

4. PREPARATORY WORKS

4.1 Removal of Plaster and Loose Material:

- Remove all existing plaster, paint, putty, and loose mortar up to sound masonry.
- Remove all unsound bricks, friable mortar, and hollow patches.

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- Clean surfaces thoroughly using wire brushing and air/water jetting.

4.2 Masonry Repairs:

- Distressed masonry shall be dismantled locally and rebuilt using matching bricks and cement mortar (minimum 1:4).
- Minor cracks and voids shall be repaired using approved repair mortar.
- Rebuilt masonry shall be properly bonded with existing work.

4.3 Raking of Joints:

- Rake all joints to a minimum depth of 25 mm or until sound mortar is reached.
- Clean joints thoroughly using wire brush and compressed air.

4.4 Repointing:

- Repoint raked joints using dense cement mortar 1:3, compacted properly to about 10 mm thickness, leaving approximately 15 mm key for receiving gunite.
- Cure repointed masonry for a minimum period of 7 days.

4.5 Pre-wetting:

- Prior to guniting, masonry surfaces shall be uniformly pre-wetted to saturated surface dry (SSD) condition.
- No free water shall be present at the time of guniting.

5. SCAFFOLDING & SAFETY

5.1 The contractor shall provide safe and adequate scaffolding for both internal and external faces, including platforms, bracing, guardrails, and access ladders.

5.2 Barricading and Protection:

- Barricade work areas to prevent access by occupants or pedestrians.
- Protect adjacent finishes, doors, windows, and services from rebound and dust.

5.3 Personal Protective Equipment (PPE):

- All workers shall use helmets, safety shoes, gloves, goggles/face shields, and dust masks or respirators.

6. MESH FIXING

6.1 Mesh shall be fixed securely, properly aligned, and tensioned to avoid sagging or drumming.

6.2 Mesh Laps:

- Minimum lap of 150 mm at all joints.

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- Laps shall be tied using galvanized binding wire at 150 mm intervals.

6.3 Fixing to Masonry:

- Provide anchors at maximum 450 mm c/c both horizontally and vertically.
- Reduce spacing to 300 mm near corners, openings, and distressed areas.
- Provide spacers/chairs so that mesh remains approximately at mid-depth of the 40 mm gunite layer.

6.4 Corners and Junctions:

- Mesh shall be wrapped around corners wherever feasible.
- Where wrapping is not possible, provide adequate overlap and additional anchors.
- Corners and re-entrant pockets shall be filled first during guniting.

7. ATTACHMENT TO RCC MEMBERS

7.1 RCC Surface Preparation:

- Lightly roughen RCC surfaces to remove laitance and coatings.
- Clean and pre-wet to SSD condition.

7.2 Dowels into RCC:

- Provide 8 mm dia chemical anchors/dowels into RCC stiffener columns and lintel band.
- Spacing: 300 mm c/c vertically along stiffeners and along lintel band, for each face.
- Dowels shall project sufficiently to tie the mesh and remain embedded within gunite.

7.3 Connection of Mesh:

- Mesh shall be tied to RCC dowels using galvanized binding wire.
- Provide U-clips or spacers as required to maintain correct cover.

7.4 Transitions:

- Maintain continuous gunite thickness across RCC–masonry interfaces without feather edges.

7.5 Openings:

- Provide additional short dowels or U-bars near openings adjacent to RCC stiffeners.

7.6 Through-Ties at Parapet Level:

- Through-ties shall be provided only at parapet level.
- Location: Mid-height of parapet.
- Spacing: 900 mm c/c.
- Ties shall be 8 mm bars or approved connectors, properly grouted/anchored to connect both inner and outer meshes.

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8. GUNITING METHODOLOGY

8.1 One Face at a Time:

- Complete guniting on one face, including curing, before starting the opposite face.

8.2 Thickness and Layering:

- Total gunite thickness: 40 mm.
- Apply in two layers:
 - Layer 1 (18–22 mm) to encapsulate mesh.
 - Layer 2 to achieve final thickness.
- Remove rebound and check for hollows between layers.

8.3 Application:

- Nozzle distance typically 0.6–1.0 m.
- Nozzle shall be held near normal to the surface.
- Only experienced nozzlemen shall be employed.

8.4 Rebound:

- Rebound shall be removed continuously and shall not be reused.

8.5 Joints:

- Construction joints shall be straight and properly prepared before resumption.

8.6 Finish:

- Leave a rough natural gunite finish suitable for plaster.
- Apply plaster only after adequate curing and surface preparation.

9. CURING

- Start curing within 24 hours of guniting.
- Cure continuously for a minimum of 7 days (preferably 10–14 days).
- Protect from rapid drying, rain, and impact.

10. QUALITY CONTROL

- Inspect surface preparation, mesh fixing, anchorage, and thickness.
- Thickness tolerance: ± 5 mm.
- Hollow or debonded areas shall be cut out and re-gunited.

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11. MODE OF MEASUREMENT

11.1 Measurement shall be in square metres (m²) of actual surface area gunited.

11.2 The rate shall include:

- All preparatory works, masonry repairs, raking and repointing.
- Supply and fixing of mesh, anchors, binding wire, dowels.
- Through-ties at parapet level.
- Guniting, rebound removal, curing.
- Scaffolding, barricading, safety arrangements, and disposal of debris.

11.3 Openings larger than 0.50 m² shall be deducted.

11.4 No separate payment shall be made for rebound, temporary works, or curing.

12. BOQ ITEM DESCRIPTION

Providing and applying cement mortar gunite (shotcrete) 40 mm thick in CM 1:3 on internal and external faces of existing masonry walls for gravity and seismic strengthening, including removal of existing plaster, masonry repairs, raking and repointing of joints, supply and fixing of 50 mm × 50 mm galvanized welded wire mesh of 3 mm diameter with galvanized binding wire, fixing of anchors and chemical dowels into masonry and RCC stiffener columns and lintel band, provision of through-ties at parapet level at 900 mm c/c, application of gunite in two layers, curing for minimum 7 days, scaffolding, barricading, safety measures, and all incidental works, complete as per specifications, drawings, and directions of the Engineer-in-Charge.

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Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

G

STRUCTURAL STEEL STRENGTHENING WORKS Specification, Methodology, Mode of Measurement & BOQ DISCRIPTION

STRUCTURAL STEEL STRENGTHENING WORKS

**(For RCC beam steel jacketing / underpinning, ISMB slab support, runner
at slab-wall junction, and plan bracing diaphragm)**

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Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

1. Scope of Work

This document covers the minimum technical requirements for supply, fabrication, erection and protection of structural steel strengthening works including:

- Structural steel jacketing of existing RCC beams and local underpinning/needle-beam support as shown on drawings.
- Supporting existing RCC slabs and/or beams by ISMB (or equivalent) sections, including bearing plates, stiffeners and end seating details.
- Providing continuous structural steel runner/channel/plate at slab-wall junction along masonry load bearing walls after completion of gunite jacketing, to achieve positive wall-to-diaphragm connection.
- Providing structural steel bracing in plan below slab to develop diaphragm action and distribute lateral forces into gunite-jacketed masonry walls.
- All steel-to-steel connections (welded/bolted) and steel-to-RCC / steel-to-masonry connections using post-installed fasteners as per drawings.
- Achieving 100% bearing/contact between steel and substrate using non-shrink grout/packing/shims as good engineering practice.

2. Design Responsibility & General Requirements

All member sizes, connection forces, weld sizes, anchor sizes/quantities, embedment depths, edge distances and spacing shall be as per approved structural drawings and design calculations issued by the Structural Engineer. The Contractor shall prepare shop drawings and method statements consistent with this document and site constraints.

Where existing substrate strength/quality is uncertain (aged RCC, weak/variable masonry, unknown mortar/brick type), proof/pull-out tests of chemical anchors shall be carried out and anchorage design shall be verified/updated prior to full-scale installation.

3. Reference Standards (Latest Revisions)

Unless otherwise specified, comply with the following (or approved equivalent international standards):

- IS 800: General Construction in Steel (Limit State Method).
- IS 2062: Hot Rolled Medium and High Tensile Structural Steel (material).
- IS 816 and IS 9595: Code of practice for metal arc welding of structural steel.
- IS 814: Covered electrodes for manual metal arc welding.
- IS 1367 / IS 1364 / IS 1363: Technical supply conditions and dimensions for bolts, nuts and washers.
- IS 456: Plain and Reinforced Concrete – for drilling, cover considerations and local repair.
- EOTA ETAG 029: Metal injection anchors for use in masonry (design/installation framework).
- EOTA TR 053: Job-site tests of metal injection anchors in masonry (pull-out/proof-load tests).
- EOTA EAD 330499 (Bonded fasteners for use in concrete) / manufacturer ETA or ICC-ES evaluation for bonded anchors.

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4. Materials

4.1 Structural Steel

- Rolled sections (ISMB/ISMC/ISA/plates/flats) shall be as per drawings and conform to IS 2062 (minimum grade E250 unless noted otherwise).
- Plates shall be straight, free from lamination and excessive pitting.
- All steel shall be supplied with mill test certificates and heat numbers traceable to certificates.

4.2 Welding Consumables

- Electrodes/wires shall be compatible with base metal grade and welding process, conforming to IS 814 and manufacturer recommendations.
- Welding shall be carried out by qualified welders with valid performance qualification records.

4.3 Bolts and Nuts

- Bolts/nuts/washers shall conform to relevant IS 1367/1364/1363; property class and diameter as per drawings.
- High-strength friction grip (HSFG) bolts, if specified, shall be installed with calibrated torque/tension control.

4.4 Post-installed Fasteners / Chemical Anchors

Provide only proprietary, tested two-component polymer-based injection mortars/adhesives suitable for the base material, with published load data and third-party approvals (ETA/ICC-ES or equivalent).

A) Steel to RCC (epoxy-grouted chemical anchors):

- Use epoxy or high-performance hybrid adhesive anchor systems approved for anchoring in concrete (cracked/uncracked as required) and suitable for the site temperature and installation conditions.
- Typical acceptable products (or approved equal): Hilti HIT-RE / HIT-HY series, fischer high-performance injection mortars, Sika AnchorFix series (subject to design and approvals).
- Anchor elements: threaded rods or rebar with grade, diameter and coating as per design (zinc plated / HDG / SS as required).

B) Steel to masonry load bearing wall (polymer-based chemical anchors):

- Use injection mortar systems approved for hollow and/or solid masonry with ETA for masonry (framework per ETAG 029 / EAD 330076).
- Typical acceptable products (or approved equal): Hilti HIT-HY 270 (hybrid mortar with ETA for masonry), fischer FIS V Plus (approved for masonry), Sika AnchorFix-3030 (suitable for hollow and solid masonry).
- Use perforated sieve sleeves/screen tubes for hollow/perforated masonry units; for solid masonry, direct injection may be used as per product approval.
- For uncertain masonry unit/mortar type or where ETA does not cover the exact substrate, carry out job-site tests and evaluate capacities as per EOTA TR 053 prior to bulk installation.

4.5 Bedding and Contact Grouting

- All bearing interfaces between steel and RCC/masonry shall achieve full, uniform contact.

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- Use pre-packed non-shrink cementitious grout (flowable/precision grout) for gap filling and bedding; comply with ASTM C1107 or equivalent. Minimum compressive strength 40 MPa at 28 days unless specified otherwise.
- Use steel shims/pack plates only where allowed by design; all voids behind shims shall be fully grouted.
- For thin gaps and surface undulations, use polymer-modified repair mortar/non-shrink mortar as directed by Engineer.

4.6 Corrosion Protection

- Unless otherwise specified: blast clean to Sa 2.5 (where feasible) or power-tool clean to St 3 for existing steel; remove oil/grease.
- Apply zinc-rich epoxy primer and compatible epoxy/polyurethane top coats to achieve total DFT as specified (typically 200–300 microns for internal severe exposure).
- All contact faces to be grouted may be left unpainted where required for bond; protect immediately after grouting.

5. Methodology / Method Statement

5.1 Pre-execution Checks and Planning

- Study structural drawings, strengthening scheme, connection details, tolerances and sequencing with the Project Engineer.
- Prepare detailed shop drawings and erection sequence drawings, including temporary works (propping/shoring) design and load path.
- Carry out condition survey (levels, deflections, cracks), and mark all proposed drill locations; confirm services/embedded items.
- Scan RCC members for reinforcement (rebar locator/ferroscan) before drilling; adjust hole locations to avoid cutting main bars.
- Confirm that gunite jacketing (where applicable) has achieved required curing and strength before drilling through it for runner anchors.

5.2 Temporary Propping / Load Transfer

- Provide engineered propping to safely relieve the existing member before cutting pockets, drilling, or installing steel supports.
- Props/needle beams shall be founded on sound substrates with spreader beams/sole plates.
- Monitor deflection/crack movement during propping and strengthening; stop work and inform Engineer if abnormal movement is observed.

5.3 Surface Preparation and Setting Out

- Remove plaster/paint/loose concrete and expose substrate as needed for proper contact and inspection.
- Dress contact surfaces by chipping/grinding high spots; clean dust and laitance.
- Mark centerlines, levels and reference points to maintain alignment and required camber (if any).

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5.4 RCC Beam Strengthening by Steel Jacketing / Underpinning

- Fabricate steel jacket components (channels/plates/angles/stiffeners) as per shop drawings; trial assemble where feasible.
- Lift and fit steel jacket around existing beam with adequate working clearance; ensure member is correctly aligned and supported.
- Provide shear transfer/holding brackets and post-installed anchors into RCC as per drawings. Drill holes with rotary percussion, avoiding rebar; clean holes by blow-brush-blow as per anchor manufacturer.
- Inject epoxy/hybrid adhesive and install threaded rods/rebar to required embedment; maintain correct projection and curing time before loading.
- Bring steel jacket into full contact using shims/packing and inject non-shrink grout to fill residual gaps; ensure continuous grout contact without voids.
- Complete welding/bolting of jacket seams, stiffeners and splice details; control heat input to avoid damage to existing concrete.
- Repair drill/pocket areas and exposed concrete with compatible repair mortar/micro-concrete after completion.

5.5 Supporting Existing Slab by ISMB (Needle Beam / Underpinning)

- Provide temporary propping to transfer slab load prior to installing ISMB supports.
- Form end seats/pockets in RCC or masonry as shown; provide bearing plates and leveling shims.
- Install ISMBs to line and level; check bearing length and clearance.
- Grout under bearings and between bearing plate and substrate with non-shrink grout to achieve 100% contact; cure as per manufacturer.
- Where specified, connect ISMBs to slab/beam using steel cleats and post-installed anchors to prevent slip and provide composite action.

5.6 Runner at Slab-Wall Junction on Gunit-Jacketed Masonry Walls

- After gunit jacketing is completed and cured, mark runner alignment and anchor locations along the wall.
- Drill through gunit layer and into underlying masonry to required diameter and depth; for brick/stone masonry, prefer rotary drilling (avoid excessive hammering) to prevent cracking.
- Clean holes thoroughly as per injection mortar manufacturer; install sieve sleeves for hollow/perforated masonry.
- Inject polymer-based injection mortar and install threaded rod/anchor; allow full curing before tightening nuts or applying load.
- Fix runner (channel/plate) with washers/nuts; ensure continuous bearing to wall by packing/grouting behind runner with non-shrink mortar/grout to eliminate voids.
- Provide corrosion protection touch-ups at cut edges and after installation.

5.7 Plan Bracing Below Slab to Develop Diaphragm Action

- Install bracing members (angles/flats/rods/ISMC) between ISMB supports and runners as per drawings to form in-plane triangulation.
- Provide gusset plates, cleats and stiffeners as detailed; ensure bracing lines are straight and free from unwanted eccentricities.

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- Where tension-only rods are used, provide turnbuckles and pre-tension to remove slack as specified; lock nuts after final adjustment.
- Complete welds/bolts and re-check alignment; ensure bracing does not clash with services and maintains specified headroom.

5.8 Inspection, Testing and Acceptance

- Welding: visual inspection for all welds; NDT (DPT/UT) for critical welds if specified by Engineer.
- Bolting: torque/tension verification for HSFG bolts using calibrated wrench; re-check after 24 hours if required.
- Chemical anchors in RCC/masonry: proof-load or pull-out tests at agreed frequency (minimum 1% of anchors or as directed). For masonry, evaluate results as per EOTA TR 053 when substrate is uncertain.
- Grouting: ensure proper mixing, flow and curing; check for voids and complete bearing contact.
- Prepare as-built drawings, anchor installation records, and material certificates for Engineer approval.

5.9 De-propping / Load Re-introduction

- Remove temporary supports only after anchors have fully cured and grout has achieved specified strength.
- De-prop gradually in stages, monitoring deflection/cracks; record final levels for reference.

6. Mode of Measurement

Unless the contract specifies otherwise, measurement shall be based on the following principles:

6.1 Structural Steel Work

- Measured in kilogram (kg) of fabricated and erected steel based on theoretical weight from approved shop drawings (IS section tables), including all plates, cleats, stiffeners, gussets, pack plates and bracing members.
- Rate shall include cutting, drilling, shop fabrication, trial assembly (if required), transport, hoisting, erection, alignment, welding, bolting, temporary tack welds and all consumables.
- Rate shall include surface preparation and paint system (primer + coats) unless measured separately.

6.2 Chemical Anchors / Fasteners

- If measured separately: measured in Numbers (No.) for each anchor of specified diameter and embedment, including drilling, cleaning, resin, threaded rod/rebar, sleeves (for masonry), fixtures, setting and curing.
- If included within steel item: no separate measurement; anchors shall be deemed included as per drawings.

6.3 Non-shrink Grout / Bedding Mortar

- If measured separately: measured in kilograms (kg) or bags as per manufacturer packing, or in cubic metre (m³) based on placed volume for bearing grout.
- If included: deemed included for all required full-contact bedding/packing.

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6.4 Testing and Documentation

- Proof/pull-out tests of anchors: measured per test (No.) including load application rig, reaction arrangement, gauges, calibration and reporting.
- NDT of welds: measured per metre of weld or per test as specified.

7. BOQ Item Descriptions (Typical)

Item 1: Structural Steel Strengthening System (Comprehensive)

Providing and fixing complete structural steel strengthening system including beam jacketing/underpinning, ISMB slab support beams, continuous runner at slab-wall junction on gunite-jacketed masonry walls, and plan bracing members below slab to develop diaphragm action, all as per approved structural drawings and specifications, including:

- Supply of IS 2062 steel sections/plates, fabrication, drilling, welding, bolting, stiffeners, gusset plates, cleats, pack plates and all accessories;
- Steel-to-steel welded/bolted connections;
- Steel-to-RCC fixing using post-installed epoxy/hybrid chemical anchors with drilling, hole cleaning, adhesive injection, threaded rods/rebar, nuts/washers and curing;
- Steel-to-masonry fixing using polymer-based injection mortar chemical anchors suitable for solid/hollow masonry with sieve sleeves where required, including drilling through gunite and into masonry, hole cleaning, adhesive injection, installation and curing;
- Achieving 100% bearing/contact by providing non-shrink grout / non-shrink mortar packing and shims as required, including bedding at end seats and behind runners;
- Surface preparation and corrosion protection painting system to specified DFT;
- All scaffolding, propping/temporary supports, safety measures, handling, alignment, testing, records and as-built documentation complete.

Mode of Measurement: kg of installed structural steel (complete system) OR as per contract schedule.

Rate to include all materials, labour, tools, tackles, consumables and incidentals to complete the work.

Item 2 (Optional): Proof/Pull-out Tests of Chemical Anchors

Carrying out proof/pull-out tests of installed chemical anchors in RCC/masonry including reaction arrangement, calibrated jack, gauge, loading protocol, recording load-displacement/ultimate load and reporting; complete as directed.

Mode of Measurement: No. of tests.

8. Notes and Engineering Good Practices

- Do not load anchors or remove props before adhesive full cure time (as per product datasheet considering ambient temperature).
- Maintain minimum edge distances and spacing to prevent masonry cracking and concrete splitting; adjust locations if required by rebar scanning and site constraints.

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Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

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- Use appropriate drilling mode: avoid heavy hammering in masonry; use sieve sleeves in perforated/hollow units.
 - Where steel bears on masonry/RCC, ensure adequate bearing length/area; rectify weak substrate by local rebuilding/patching before seating.
 - All deviations from drawings/specifications shall be approved by the Engineer in writing.

9. External Reference Documents (for anchor approvals)

The following publications are recommended for anchor selection, installation, and job-site testing (latest editions):

- Hilti HIT-HY 270 (ETA for masonry) – manufacturer technical documentation and ETA.
- fischer FIS V Plus – manufacturer technical documentation and ETA approvals for masonry and concrete.
- Sika AnchorFix-3030 – manufacturer data indicating suitability for hollow and solid masonry and concrete.
- EOTA ETAG 029 and EOTA TR 053 for design/testing of injection anchors in masonry; EOTA EAD 330499 for bonded anchors in concrete.

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H

GRID-BASED CONSOLIDATION / IMPREGNATION INJECTION IN EXISTING RCC MEMBERS (OLD M15 CONCRETE)

Tender Specification, Methodology, Mode of Measurement and BOQ Item Descriptions

Manish V. Doshi	Repair, Strengthening & Facelifting Specifications
Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

1. Scope and Intent

1.1 Scope

Providing and executing grid-based drilling and pressure injection through injection nipples/packers/ports in existing RCC members (slabs, beams, columns, walls, ribs, lintels, etc.) of old concrete (typically M15, 50+ years), including setting out, rebar scanning, drilling, cleaning/conditioning, nipple/packer installation, injection, finishing, patching, complete documentation and QA/verification as directed by the Consultant/Engineer-in-Charge.

1.2 Intent (Project-Specific Background)

This work is intended for old RCC where it is reasonably expected that concrete contains micro-voids, micro-crack network and internal discontinuities, particularly in zones where UPV results are poor while rebound hammer readings are comparatively satisfactory. The injection treatment is therefore specified as consolidation/impregnation to:

- improve internal integrity/continuity of interconnected defects,
- reduce permeability and water pathways (where applicable),
- improve service performance (stiffness/response) to the extent achievable by impregnation,

without claiming automatic strength increase beyond original design unless verified by engineering assessment and testing.

2. References (for tender compliance)

1. IS 13311 (Part 1): 1992 - Non-destructive testing of concrete - Methods of test - Ultrasonic pulse velocity (UPV).
2. IS 13311 (Part 2): 1992 - Non-destructive testing of concrete - Methods of test - Rebound hammer.
3. IS 15988: 2013 - Seismic evaluation and strengthening of existing reinforced concrete buildings.
4. ACI RAP-1 - Structural crack repair by epoxy injection (injection sequence, refusal concept, QA).
5. ACI 546R - Concrete Repair Guide (grout selection, flushing rationale, grouting sequence concepts).
6. EN 1504-5 (where adopted) - Products and systems for the protection and repair of concrete structures - Injection of concrete (categories F/D/S).

Note: BIS standards primarily cover evaluation/NDT and overall strengthening framework; injection execution is typically referenced to ACI/EN guidance plus manufacturer method statements.

3. Limitations and Verification Basis

3.1 Limitations (mandatory note)

- This work shall not be construed as guaranteed strengthening beyond original design capacity unless demonstrated by engineering analysis and verification.

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- If active corrosion, delamination, spalling, or continuing movement/distress is present, root-cause control and concrete/steel repairs shall precede consolidation injection, as directed.

3.2 Verification

Acceptance shall be based on:

- point-wise injection records (pressure/intake/refusal) and material reconciliation, and
- post-treatment verification by UPV/rebound mapping and/or selective coring as directed.

4. System Selection (zone-wise, by Consultant after trial)

Injection material shall be selected as follows:

4.1 Structural consolidation (dry or suitably conditioned zones)

Low viscosity rigid epoxy injection resin, preferably compliant to EN 1504-5 Category F (force-transmitting), where structural impregnation is intended.

4.2 Filling of larger internal voids/honeycombing where injectability is feasible

Cementitious grout slurry/microfine cement grout/non-shrink grout slurry, used only where flow paths/openings permit.

4.3 Wet/leaking zones (sealing stage)

PU/acrylate gel injection for water cut-off/sealing only (non-structural). If required, sealing injection may be executed as Stage 1, followed by structural consolidation (Stage 2) after moisture condition becomes compatible with the structural resin system.

Final selection and staging shall be by Consultant based on moisture, defect connectivity, member type, and trial results.

5. Grid Spacing, Edge Distance, Rebar Avoidance, Drilling Depth

5.1 Grid spacing

- Grid shall be set out as per site condition and defect severity, in concurrence with Consultant.
- Not less than 230 mm and not more than 600 mm in either direction.
- Grid shall be tightened near beam-column joints, supports, re-entrant corners, openings and low-UPV pockets as directed.

5.2 Minimum edge distance (drilling point location)

- Minimum edge distance ≥ 75 mm from any free edge/corner/opening edge OR $\geq 6 \times$ drill hole diameter, whichever is greater.
- Avoid drilling directly on corners/arris.

5.3 Reinforcement avoidance and point shifting

- Drill locations shall be confirmed by cover meter/rebar scanner prior to drilling.

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- If reinforcement/services conflict occurs, the point shall be shifted suitably while maintaining the intent of grid coverage (included in point rate). Final as-built grid shall be recorded.

5.4 Drilling depth

- Drilling depth shall be fixed strictly as per the grout/chemical manufacturer's written guideline/method statement and finalized by Consultant considering member thickness, reinforcement layout and access.
- Multi-face injection and/or staged depths may be adopted as directed.

6. Injection Nipples / Packers / Ports (material, type, diameter)

6.1 Permitted types

Injection points may use any of the following, as approved by Consultant and compatible with the selected injection material and pressure:

- Mechanical drill-hole packers (expandable sleeve type), or
- Injection nipples/ports, including PVC nipples/ports where possible, properly sealed into drilled holes.

Selection shall consider expected pressure, grout viscosity, substrate quality, leakage paths, and ease of removal/patching.

6.2 Materials (minimum requirements)

- Mechanical packers: corrosion-resistant body with sealing sleeve suitable for old/weak concrete.
- PVC nipples/ports: heavy-duty PVC injection nipples/ports permitted where pressures are low-to-moderate and where compatible with the injection chemical/grout system and manufacturer's method statement. Proper sealing to concrete shall be ensured to prevent blowout.

6.3 Diameter range

- Typical nipple/packer sizes: 8 mm / 10 mm / 13 mm (final based on grout viscosity/flow and manufacturer recommendation).
- Drill hole diameter shall suit the selected nipple/packer system as per manufacturer.

6.4 Old/weak concrete consideration

Fixing/tightening shall be controlled to avoid local crushing/splitting around drill hole; where surface concrete is weak, deeper seating or alternate porting may be adopted with Consultant approval.

7. Injection Pressure Control (ranges for tender guidance)

7.1 General rule

- Use minimum pressure necessary to achieve penetration; prevent new cracking, spalling, lifting, blowouts, leakage, or nipple/packer ejection.
- Manufacturer's pressure limits govern; Consultant may further restrict after trial.

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7.2 Typical pressure bands (to be confirmed by trial)

- Cementitious/microfine grout: typically up to approximately 3.5 bar unless approved otherwise by manufacturer and Consultant.
- Epoxy (rigid structural): ramp gradually; upper cap typically not exceeding approximately 13 bar unless specifically permitted by manufacturer and Consultant based on trial and safety controls.
- PU/Acrylate sealing: typically approximately 1 to 10 bar, strictly as per manufacturer method statement and site response.
- Where PVC nipples are used, allowable pressures shall be further limited to manufacturer/Consultant approval to avoid nipple failure or blowout.

8. Methodology (stepwise)

8.1 Pre-works and trial (mandatory)

1. Identify zones based on NDT mapping and site inspection; mark wet/leak zones separately.
2. Execute a trial panel to finalize grid within 230-600 mm, hole diameter/depth, nipple/packer type, pressure strategy, refusal criteria, and expected consumption.

8.2 Setting out, scanning, drilling

1. Set out grid with Consultant concurrence; ensure edge distance compliance.
2. Scan reinforcement; shift points wherever needed due to bars/services while maintaining grid intent; record as-built.
3. Drill holes to specified diameter and depth (manufacturer guideline).

8.3 Cleaning/conditioning

1. Remove dust by vacuum and oil-free air; condition substrate per material requirements.
2. For cementitious grouting zones: flushing/wetting as per method statement and Consultant direction.
3. For epoxy zones: ensure dryness/compatibility per manufacturer.

8.4 Nipple/packer installation

1. Install nipples/packers/ports; ensure tight seal and stability at low trial pressure.

8.5 Injection

1. Inject systematically (generally bottom-up for vertical faces; bay-by-bay for slabs).
2. Record pressure and intake.
3. Continue until refusal or controlled bleed as per approved procedure.

8.6 Secondary pass and finishing

1. Re-inject points directed by Consultant after initial set/cure.

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2. Remove nipples/packers where applicable; patch holes flush with approved repair mortar/grout and finish.

8.7 Documentation and QA

1. Maintain point-wise injection log and as-built layout.
2. Assist for post-treatment UPV/rebound and/or coring as directed.

9. Mode of Measurement (two-part - mandatory)

Part 1: Injection nipples/packers/ports (fixed)

Unit: Nos.

Includes: setting out, rebar scanning and shifting, drilling, cleaning/conditioning, nipples/packers/ports, injection operation labour/plant, removal (if applicable), patching, logs, complete.

Part 2: Material consumption (variable)

Unit: kg (preferred for epoxy/PU) or L (if supplied by volume); cementitious by kg of binder or L grout as approved.

Measured by pack issue/return, batch sheets and injection log reconciliation certified by Consultant/Engineer-in-Charge.

10. BOQ Item Descriptions (copy-paste)

Item 1A - Grid injection nipples/packers/ports (Nos.)

Providing and executing grid-based drilling and installation of injection nipples/packers/ports in existing RCC members, including rebar scanning, setting out grid (spacing as per site condition with Consultant concurrence within 230-600 mm), maintaining minimum edge distance (≥ 75 mm or 6 x hole diameter whichever greater), shifting of points wherever required due to reinforcement/services/geometry while maintaining grid intent, drilling holes to diameter and depth as per manufacturer's written guideline, cleaning/conditioning, pressure injection operation with calibrated pump, removal of nipples/packers where applicable and patching of holes complete, including logs and as-built layout, all as directed. Unit: Nos.

Item 1B - Epoxy injection resin consumed (kg/L)

Supplying and injecting approved low-viscosity rigid epoxy injection resin for consolidation/impregnation in designated zones as per Item 1A, including mixing accessories and all incidentals, measured by actual consumption. Unit: kg (or L).

Item 2B - Cementitious grout consumed (kg/L)

Supplying and injecting approved cementitious grout slurry/microfine cement/non-shrink grout slurry in designated zones as per Item 1A, including admixtures if required, measured by actual consumption. Unit: kg (or L).

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Item 3B - PU/Acrylate sealing material consumed (kg/L)

Supplying and injecting approved PU/Acrylate resin/gel in wet/leaking zones for water cut-off/sealing as directed, measured by actual consumption. Unit: kg (or L).

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Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

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SPECIFICATION, METHODOLOGY, MODE OF MEASUREMENT & BOQ DESCRIPTION

FOUNDATION STRENGTHENING OF EXISTING LOAD-BEARING MASONRY WALL FOUNDATIONS

BY ALTERNATE BLOCK UNDERPINNING, FOUNDATION WIDENING AND COMPOSITE JACKETING

Client / Project	Rajkot Nagrik Sahakari Bank Ltd., Parabazar Branch, Rajkot
Location	Rajkot, Gujarat
Prepared By	Manish V. Doshi, Consultant Structural & Civil Engineer, Rajkot
Document	Chapter I - Foundation Strengthening Specification
Measurement Unit	Cum (Cubic Metre)

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Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

1.0 Scope and Intent

1.1 Scope

This specification covers the structural strengthening of existing load-bearing masonry wall foundations by controlled alternate block underpinning, foundation widening, composite jacketing, dowel anchorage, shear connection and associated rehabilitation works, as indicated in the approved strengthening drawings and particularly in Section Z-Z.

The work includes all operations required for safe and complete execution of the strengthening system, including setting out, condition mapping, temporary supports, excavation in short alternate blocks, exposure of existing foundation, substrate preparation, drilling and anchoring of pins, providing plum concrete widening on both sides, staged concreting, compaction, curing, backfilling, guniting of masonry wall face, RCC coping, monitoring, testing, documentation and all incidental works.

The work shall be treated as a structural underpinning and foundation rehabilitation activity. It shall not be treated as ordinary excavation, simple concrete filling or non-structural masonry repair. The existing building shall remain supported during execution and the Contractor shall plan every operation accordingly.

1.2 Intent

The intent of the strengthening scheme is to improve the foundation support conditions of the existing masonry load-bearing walls without dismantling the wall and without removing the original foundation continuity. The new foundation widening shall be constructed on both sides of the existing foundation and shall be positively connected to the existing masonry foundation so that old and new portions behave as a composite foundation unit.

- Increase the effective foundation width and improve bearing pressure distribution on supporting soil.
- Improve gravity load transfer from the existing masonry wall into the enlarged foundation mass.
- Reduce vulnerability to differential settlement due to local bearing stress concentration.
- Create mechanical interlock between old and new foundation through dowels and shear connectors.
- Provide a stable, durable and inspectable strengthening system that can be executed in a controlled sequence.
- Maintain stability of the existing structure at all stages of construction.

The specification is intentionally written in a conservative manner because uncontrolled excavation below or adjacent to existing load-bearing walls can cause serious cracking, settlement, rotation or local instability. Whenever there is any conflict between speed of execution and structural safety, structural safety shall govern.

2.0 Design Philosophy and Structural Basis

The strengthening arrangement shown in Section Z-Z is based on foundation widening on both faces of the existing masonry wall/foundation. The widening is shown with approximately 450 mm projection on each side of the existing wall foundation and a total strengthening depth of approximately 1200 mm below ground level, divided into two vertical lifts of about 600 mm each.

The existing masonry load-bearing wall is retained. The foundation is not to be continuously undercut. The new plum concrete widening is introduced in short alternate blocks so that the building load is always

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supported by the remaining untouched portions of the existing foundation and by already completed strengthened blocks.

The key engineering principles are as follows:

- The existing foundation shall remain effective during execution.
- Continuous excavation along the wall length is prohibited.
- Zone-1 and Zone-2 blocks shall be executed in alternate sequence only.
- Adjacent blocks shall not be opened simultaneously.
- New widening shall be tied to existing masonry foundation using 12 mm diameter dowel pins and 16 mm diameter shear pins/connectors as detailed in drawings.
- Plum concrete shall be placed and compacted in such a way that it fills the full interface zone and provides a continuous bearing mass.
- The completed system shall act as positive foundation widening/jacketing, not as loose side packing.

The Engineer-in-Charge / Structural Consultant shall have full authority to reduce block length, alter sequence, restrict the number of open blocks, order additional supports, stop the work, or require additional waiting period based on observed condition of masonry, soil, cracks, water ingress or structural behaviour.

3.0 Reference Standards and Technical Framework

The work shall generally comply with the latest revisions of the following Indian Standards and accepted engineering practice, to the extent applicable to old masonry foundation strengthening and rehabilitation works:

- IS 456 - Plain and Reinforced Concrete - Code of Practice, for concrete workmanship, durability, cover, curing and general RCC requirements.
- IS 1905 - Code of Practice for Structural Use of Unreinforced Masonry, for masonry behaviour and general structural considerations.
- IS 13935 - Seismic Evaluation, Repair and Strengthening of Masonry Buildings - Guidelines, for repair philosophy and strengthening of masonry buildings.
- IS 15988 - Seismic Evaluation and Strengthening of Existing Reinforced Concrete Buildings, for general rehabilitation philosophy where applicable.
- IS 9012 - Recommended Practice for Shotcreting, for guniting and shotcrete execution.
- IS 13645 - Guniting over masonry surfaces, wherever applicable for masonry surface gunite works.
- IS 1786 - High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.
- IS 383 - Coarse and Fine Aggregate for Concrete.
- IS 269 / IS 8112 / IS 12269 - Cement specifications.
- IS 516 - Methods of tests for strength of concrete.
- IS 1199 - Methods of sampling and analysis of concrete, where applicable.
- National Building Code of India, for safety, workmanship and general construction requirements.

Where Indian Standards do not provide specific procedural guidance for old masonry foundation underpinning, the work shall follow sound engineering practice and the instructions of the Structural Consultant. Proprietary anchoring materials shall be used strictly in accordance with manufacturer data sheets, approved method statements and site trial confirmation.

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4.0 Definitions

Term	Meaning
Existing Foundation	The original masonry or stone/brick foundation supporting the load-bearing wall.
Foundation Widening	New foundation mass provided on both sides of the existing foundation to increase effective bearing width.
Composite Jacketing	A strengthening arrangement where old and new foundation portions are mechanically tied and act together.
Zone-1 / Zone-2 Blocks	Alternate short blocks marked in plan for staged underpinning execution.
Open Block	A foundation segment where excavation has been made and original side support is temporarily exposed.
Underpinning	Controlled strengthening work below/adjacent to an existing foundation while the structure remains supported.
SSD Condition	Saturated surface dry condition of masonry/concrete surface, where surface is damp but free water is absent.
Hold Point	A mandatory inspection stage where work shall not proceed without Engineer approval.

5.0 Materials

5.1 Cement

Cement shall be Ordinary Portland Cement of approved make conforming to IS 269, IS 8112 or IS 12269 as applicable. Cement shall be fresh, free from lumps, stored in dry conditions and used within the permitted shelf life. Cement of doubtful quality shall not be used.

5.2 Aggregates for Concrete

Fine and coarse aggregates shall conform to IS 383. Aggregates shall be clean, hard, dense, durable and free from clay, silt, organic impurities, deleterious salts and soft particles. Coarse aggregate for the concrete matrix of plum concrete shall be suitably graded and shall generally not exceed 40 mm nominal size unless otherwise approved.

5.3 Plum Stones

Stones used as plums shall be hard, sound and durable. Weathered, laminated, porous, friable or clay-coated stones shall not be permitted. The stones shall be thoroughly cleaned and wetted before use. Stone size shall generally range from 150 mm to 300 mm, subject to available space and proper concrete encapsulation.

The total volume of plums shall not exceed 40 percent of the completed plum concrete volume unless specifically approved. Each stone shall be fully surrounded by concrete matrix. Stone-to-stone contact, stone contact with existing masonry foundation, and stone contact with formwork shall not be permitted. Minimum concrete cover around plums shall generally be 75 mm.

5.4 Plum Concrete

Foundation widening shall be executed using plum concrete in nominal proportion 1:3:6 or as shown in drawings. The concrete matrix shall be workable enough to fully fill voids around plums and existing foundation irregularities. Concrete shall be mixed in mechanical mixers unless specifically permitted otherwise for very small quantities.

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5.5 Reinforcement / Dowel and Shear Connector Steel

Reinforcement bars used as dowel pins and shear connectors shall conform to IS 1786. Unless otherwise specified in drawings, minimum grade shall be Fe500D. Bars shall be free from oil, grease, loose rust, mud and deleterious material.

- 12 mm diameter dowel pins shall be provided at 600 mm c/c, centrally placed and on both faces, or as shown in drawings.
- 16 mm diameter shear pins/connectors shall be provided at 600 mm c/c both ways and both faces, or as shown in drawings.
- Bars shall be drilled and anchored into existing masonry/foundation and embedded into the new foundation widening.

5.6 Anchoring Grout / Chemical Anchor

Dowel bars and shear connectors shall be fixed using approved non-shrink cementitious anchoring grout or approved chemical anchoring resin suitable for masonry and old foundation substrates. The system shall be approved by the Engineer prior to use. Hole diameter, embedment depth, hole cleaning, injection quantity, bar insertion method and curing time shall strictly follow approved method statement and manufacturer data sheet.

Expired materials, partially hardened materials, field-diluted resins or grout modified without approval shall not be used. For doubtful masonry, trial anchors or proof checks may be ordered by the Engineer.

5.7 Guniting Mortar

Guniting shall be cement mortar in proportion 1:3, applied to a finished thickness of 40 mm over prepared masonry surface, unless otherwise shown. Materials and workmanship shall generally comply with IS 9012 and applicable masonry guniting practice. Rebound material shall not be reused.

5.8 RCC Coping

RCC coping at ground/plinth level shall be 150 mm thick in M15 grade concrete or as shown in drawings. Reinforcement, if shown, shall be provided as per drawings. Coping shall be properly bonded with the masonry surface and shall be cured adequately.

5.9 Water

Water used for mixing, cleaning and curing shall be clean and free from injurious quantities of oil, acids, alkalis, salts, organic matter or other deleterious substances. Potable water is preferred.

6.0 Pre-Construction Investigation and Approvals

Before commencing foundation strengthening, the Contractor shall conduct a joint inspection with the Engineer-in-Charge and Structural Consultant. The purpose of the inspection is to identify existing distress, understand load paths, confirm access constraints, identify water ingress routes and finalise block-wise sequencing.

- Prepare photographic record of the wall, floor, plinth, adjacent openings, corners and visible cracks.
- Mark existing cracks and note width, orientation and approximate length.
- Identify vulnerable locations such as corners, junctions, wall offsets, openings, previous repairs and damp patches.

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- Identify existing services, drains, cables, pipes and buried obstructions.
- Confirm safe access and material handling route.
- Mark Zone-1 and Zone-2 blocks physically at site in accordance with drawings.
- Establish reference points for settlement and crack monitoring.
- Submit method statement including sequence, temporary works, dewatering, monsoon precautions and emergency response.

No excavation shall be started until the Engineer has approved the block sequence and the required safety arrangements. Any change in actual site condition shall be brought to the notice of the Engineer before proceeding further.

7.0 Alternate Block Underpinning Principles

7.1 General Principle

The foundation strengthening shall be carried out in short alternate blocks only. The purpose of alternate block execution is to ensure that while one block is under excavation or concreting, the adjacent blocks continue to support the existing wall foundation. The building shall never be left supported on a continuous excavated trench.

7.2 Zone-1 and Zone-2 System

The strengthening plan divides the wall foundation length into alternate Zone-1 and Zone-2 blocks. The Contractor shall first take up only Zone-1 blocks. Zone-2 blocks shall remain completely undisturbed during this stage. After completion, curing and securing of Zone-1 blocks, Zone-2 blocks may be taken up only with approval.

7.3 Prohibited Practices

- Opening continuous trench along full wall length.
- Opening adjacent Zone-1 and Zone-2 blocks at the same time.
- Opening both sides of a wall continuously without leaving intermediate support.
- Undercutting below the existing foundation without specific written approval.
- Leaving excavated blocks unsupported overnight without protection.
- Excavating near corners from both directions simultaneously.
- Increasing block length for convenience without Engineer approval.

7.4 Limitation on Active Blocks

Not more than three blocks of one zone shall remain open at any time. These blocks shall preferably be well separated and shall not be concentrated at one corner, one short wall length or one vulnerable bay. If the Engineer observes any distress or instability, the active number of blocks may be reduced to one block at a time.

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8.0 Detailed Execution Methodology

8.1 Setting Out

The wall centreline, existing foundation line and proposed widening line shall be marked before excavation. The limits of each block shall be painted or otherwise clearly marked. The block number, zone number and intended sequence shall be recorded in the site register. No unmarked block shall be opened.

8.2 Temporary Supports and Protection

Before excavation, the Contractor shall provide necessary temporary supports, props, struts, bracing, local relieving supports, barricades and protection arrangements. Where openings, cracks, weak masonry or heavy local loads exist near the work zone, additional shoring shall be provided as directed. Temporary works shall be designed and installed to safely support construction-stage loads and prevent accidental damage.

8.3 Excavation

Excavation adjacent to existing masonry foundations shall be carried out carefully and preferably manually in the final zone near the foundation. Heavy mechanical excavation immediately adjacent to the existing foundation shall not be permitted unless specifically approved. The excavation shall be limited to the approved block length and required depth as per Section Z-Z.

The soil directly below the existing foundation shall not be loosened. If any accidental disturbance, cavity, soft pocket or erosion below the existing foundation is noticed, work shall be stopped and the Engineer shall be informed immediately. Corrective filling, grouting, local packing or revised strengthening shall be carried out only as directed.

8.4 Surface Cleaning and Preparation

After excavation, the exposed existing masonry foundation shall be cleaned thoroughly. Loose mortar, weak stone/brick fragments, soil, vegetation, roots, organic matter and old debris shall be removed. The surface shall be roughened to create a mechanical key. Compressed air, brushing and water cleaning may be used depending upon condition. Immediately before concreting, the masonry shall be in saturated surface dry condition.

8.5 Drilling for Dowels and Shear Connectors

Drilling shall be carried out only after marking approved locations. Hole locations shall be adjusted where the existing masonry is cracked, loose or unsuitable, subject to maintaining the design intent. Rotary drilling is preferred. Excessive hammering that may loosen old masonry shall be avoided.

The drilled holes shall be cleaned by blow-brush-blow method or as required by the anchoring system. Dust, slurry and loose particles shall be completely removed. Holes shall not be filled with anchoring material until they are inspected and accepted.

8.6 Fixing of Dowel and Shear Pins

Anchoring grout or chemical adhesive shall be injected from the inner end of the hole outward to avoid air pockets. Bars shall be inserted with slow twisting motion to ensure complete wetting and full contact. Excess material shall be removed. Bars shall remain undisturbed until the anchoring system has sufficiently hardened.

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Any bar found loose, misaligned, inadequately embedded, contaminated or otherwise defective shall be removed and replaced. The Contractor shall maintain a record of bar diameter, spacing, location, embedment, material batch and date of installation.

8.7 Placement of Plum Concrete - Lower Lift

The lower lift of approximately 600 mm shall be placed first. Concrete shall be placed in such a way that it enters all irregularities and fills the interface against the existing foundation. Plums shall be inserted individually and embedded in concrete. Dumping of stones followed by pouring slurry is strictly prohibited. Concrete shall be compacted without disturbing the existing foundation or displacing the installed pins. each layer of concrete to be rammed with manual hammer or mechanical hammer

8.8 Placement of Plum Concrete - Upper Lift

The upper lift of approximately 600 mm shall be placed after the lower lift has gained sufficient initial strength and after the surface has been properly prepared. The construction joint between lifts shall be cleaned, roughened and wetted. The upper lift shall be carried to the required level as per Section Z-Z and shall be compacted thoroughly. each layer of concrete to be rammed with manual hammer or mechanical hammer

8.9 Backfilling and Restoration

Backfilling shall be carried out only after the Engineer approves the completed block. Backfill shall be selected earth or approved granular material free from debris, organic matter, large stones and deleterious material. Backfill shall be placed in layers not exceeding 200 mm and compacted properly. The completed block shall be restored to a safe condition before any adjacent or next-stage block is opened.

9.0 Zone-Wise Construction Control

9.1 Zone-1 Execution

Initially only Zone-1 blocks shall be opened. Zone-2 blocks shall remain completely untouched. The purpose is to keep the existing foundation continuous between open segments. The Engineer shall verify that no adjacent block is open and that temporary support arrangements are in place before excavation starts.

9.2 Completion of Zone-1 Before Zone-2

Zone-2 blocks shall not be opened merely because concreting of Zone-1 is completed. Zone-2 shall be opened only after Zone-1 blocks have achieved adequate strength, curing has progressed satisfactorily, backfilling has been completed and the Engineer has accepted restoration of load-bearing continuity.

9.3 Zone-2 Execution

After approval, Zone-2 blocks shall be executed in the same manner. The Contractor shall ensure that the newly completed Zone-1 blocks are not damaged, disturbed, overloaded or undermined during Zone-2 excavation. Any damage to completed work shall be rectified at Contractor's cost.

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9.4 Sequence Register

A block-wise execution register shall be maintained. It shall include block number, zone, date of excavation, depth, observed soil condition, dowel installation date, concreting date, curing period, backfilling date, inspection approvals and any distress observations.

10.0 Corner, Junction and Offset Treatment

Corners and junctions are structurally more sensitive than straight wall portions because loads from intersecting walls combine and foundation geometry may be discontinuous. Excavation at such locations shall be slower and more conservative.

- Only one corner or junction block shall normally be opened at a time.
- Blocks approaching a corner from two directions shall not be excavated simultaneously.
- Temporary diagonal bracing or local shoring shall be provided if cracks, offsets or loose masonry are present.
- The Engineer may require a shorter block length at corners and wall intersections.
- Concreting shall be completed and backfilled before any adjacent corner block is opened.
- Extra care shall be taken to fully compact concrete around irregular corner foundations.

The rate shall be deemed to include all additional care, reduced block lengths, slower sequence and temporary support required at corners and junctions.

11.0 Guniting of Masonry Wall Face

The exposed masonry wall face shall be strengthened with 40 mm thick cement mortar guniting as shown in Section Z-Z and related drawings. Guniting shall be carried out after completion of foundation strengthening or in the sequence approved by the Engineer.

Before guniting, the masonry surface shall be cleaned and all loose plaster, paint, weak mortar, dust, biological growth and unsound material shall be removed. Open joints and voids shall be repaired. The surface shall be pre-wetted to SSD condition. Gunite shall be applied in layers to achieve the specified thickness and dense finish. Rebound shall be removed continuously and shall not be reused.

The guniting work shall integrate with the foundation strengthening and coping works so that the wall surface receives continuous protection and improved structural skin action as intended by the drawings.

12.0 RCC Coping at Ground / Plinth Level

A 150 mm thick RCC coping in M15 grade shall be provided around/along the wall at ground level as shown in Section Z-Z. The coping shall provide a protective and binding element at the top of the strengthened zone and shall help in maintaining continuity of the surface treatment.

The substrate shall be cleaned and prepared before placing coping concrete. Shuttering shall be properly aligned and leak-proof. Concrete shall be compacted and finished to line, level and slope as directed. Curing shall be carried out for at least 7 days or as directed by the Engineer.

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13.0 Curing and Protection

All concrete, plum concrete, guniting and RCC coping shall be cured adequately. Minimum curing period shall be 7 days, and 14 days is preferred wherever practicable. Curing shall be carried out by wet hessian, sprinkling, ponding, curing compound or other approved method depending on location and site constraints.

Fresh work shall be protected from direct sun, rapid drying, rain, vibration, impact, contamination, traffic and premature loading. No adjacent block shall be opened if the completed block is not adequately cured or if the Engineer considers the strength gain insufficient for safe load transfer.

14.0 Monsoon Execution Protocol

Foundation underpinning during monsoon or wet conditions requires strict control. Water ingress into open excavations can soften soil, reduce bearing support, loosen masonry and endanger the structure. The Contractor shall therefore maintain monsoon precautions at all times during rainy season and whenever rainfall is forecast.

- No block shall be opened during active rainfall unless specifically permitted for emergency work.
- Open excavations shall be protected by tarpaulins, temporary covers, bunds and diversion channels.
- Surface runoff shall be diverted away from the wall and from excavation edges.
- Pumping arrangements shall be kept ready and operational.
- Water shall not be allowed to accumulate against the existing foundation.
- If soil becomes saturated or softened, the affected material shall be removed and replaced as directed.
- Concrete shall not be placed in waterlogged excavations.
- Fresh concrete shall be protected against washout.
- Open excavations shall not remain exposed for more than 48 hours during monsoon unless specifically approved.
- Corners, low-lying areas and junctions shall be given special attention because water concentration may cause local instability.

The rate shall include monsoon protection, pumping, covers, temporary drains, cleaning after rain, protection of fresh concrete and all related incidental measures required for safe execution.

15.0 Structural Monitoring and Distress Management

The Contractor shall continuously monitor the structure before, during and after each underpinning stage. Monitoring is mandatory and shall not be treated as an optional quality activity. The purpose is early detection of movement, cracking or distress so that work can be stopped before instability develops.

- Existing cracks shall be marked and monitored for change in width or length.
- New cracks shall be recorded immediately with date and location.
- Settlement markers or level points shall be observed daily during active underpinning.
- Wall plumbness shall be visually checked and measured where directed.
- Door/window distortion, jamming or sudden gaps shall be treated as warning signs.
- Bulging, separation of masonry, falling mortar or unusual sounds shall be immediately reported.

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- Photographs shall be taken before excavation, after exposure, after pin fixing, after concreting and after backfilling.

If any abnormal movement or distress is observed, the Contractor shall immediately stop excavation and concreting in the affected area, secure the structure with temporary supports, inform the Engineer and resume only after written instructions.

16.0 Quality Assurance, Hold Points and Records

The Contractor shall maintain a structured QA/QC system for the work. Inspection at each hold point shall be offered to the Engineer. Work shall not proceed beyond a hold point unless approval is given.

Hold Point	Stage	Inspection Requirement
HP-1	Before Excavation	Block marking, sequence approval, temporary support readiness, monitoring benchmarks.
HP-2	After Excavation	Depth, width, soil condition, absence of undercutting, stability of existing foundation.
HP-3	After Surface Preparation	Masonry cleaning, removal of loose material, SSD condition readiness.
HP-4	After Drilling	Hole location, diameter, embedment depth, cleanliness and suitability.
HP-5	After Dowel/Pin Fixing	Bar diameter, spacing, anchoring material, embedment, alignment and curing time.
HP-6	Before Lower Lift	Base condition, interface condition, formwork/edge control and material readiness.
HP-7	Before Upper Lift	Lower lift condition, joint preparation, no honeycombing and approved continuation.
HP-8	Before Backfilling	Completed geometry, curing status, visible defects, block safety.
HP-9	Before Guniting	Surface readiness, cleaning, masonry repair and pre-wetting.
HP-10	Final Acceptance	Geometry, finish, curing, backfill compaction, monitoring records and documentation.

The following records shall be maintained and submitted as part of completion documentation:

- Block-wise execution register.
- Daily work log and labour/equipment record.
- Photographic record before, during and after work.
- Material batch certificates for cement, steel and anchoring materials.
- Concrete/plum concrete consumption records.
- Dowel and shear pin installation records.
- Curing records.
- Monitoring and distress observation records.
- Engineer inspection and hold point approvals.
- As-built sketch showing actual completed blocks and any deviations.

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17.0 Acceptance Criteria

The completed strengthening work shall be accepted only when the Engineer is satisfied that the work has been executed in accordance with drawings, specifications and approved methodology. Acceptance shall not be based merely on completion of concreting but on the quality and stability of the entire strengthening operation.

- Block sequencing has been followed without unauthorized continuous excavation.
- Foundation widening dimensions conform to Section Z-Z and approved drawings.
- Dowel bars and shear connectors are installed at required spacing and embedment.
- Anchoring material has hardened and bars are firm.
- Plum concrete is dense, compacted and free from visible honeycombing.
- Interface between old and new foundation is fully filled.
- No settlement, rotation, cracking or structural distress has occurred due to execution.
- Backfilling is completed and compacted properly.
- Guniting surface is dense, bonded and free from hollow sound.
- RCC coping is completed to line, level and finish.
- Curing has been carried out and documented.
- All QA/QC records and photographs are submitted.

Any defective work, honeycombed area, loose interface, inadequate anchorage, settlement, cracked guniting, incomplete backfill or unauthorized deviation shall be rectified at Contractor's cost as directed by the Engineer.

18.0 Safety Requirements

The Contractor shall be fully responsible for safety of personnel, occupants, adjoining property and the existing structure during execution. Underpinning involves inherent risk and shall be carried out only under competent supervision.

- Provide barricading, caution boards and restricted access around open excavations.
- Provide safe access, lighting and working platforms.
- Provide PPE including helmets, gloves, safety shoes, masks and eye protection.
- Provide edge protection around excavations.
- Maintain emergency shoring material at site.
- Ensure no water stagnation or slippery surface remains around work area.
- Do not store heavy materials adjacent to open excavation or weak wall portions.
- Maintain housekeeping and remove debris promptly.
- Stop work immediately if unsafe condition is noticed.

The Contractor shall not claim that adherence to the drawings alone absolves him of responsibility for construction-stage safety. Execution sequence, temporary works and site safety remain the Contractor's responsibility, subject to review by the Engineer.

19.0 Risk Register and Mandatory Control Measures

Risk	Possible Consequence	Mandatory Control
Continuous excavation below wall	Wall settlement or collapse	Strict alternate block system; no adjacent

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		blocks open.
Water ingress during excavation	Soil softening and loss of support	Diversion drains, covers, pumping and no concreting in water.
Loose old masonry	Poor anchorage and interface failure	Cleaning, local rebuilding and Engineer approval before concreting.
Inadequate hole cleaning	Dowel pull-out or poor bond	Blow-brush-blow procedure and hold point inspection.
Poor plum concrete placement	Voids and ineffective composite action	Individual stone placement and proper compaction.
Corner excavation	Combined load concentration and cracking	One block at a time, additional shoring and reduced length.
Premature adjacent excavation	Insufficient strength in completed block	Mandatory curing and Engineer approval before next block.
Unrecorded cracking	Delayed distress identification	Daily monitoring and photographic records.

20.0 Mode of Measurement

20.1 Unit of Measurement

The unit of measurement for the comprehensive BOQ item shall be Cubic Metre (Cum).

20.2 Basis of Measurement

Measurement shall be made as the net completed volume of permanent foundation widening / foundation jacketing actually incorporated into the work and accepted by the Engineer. The volume shall generally be computed from approved drawings and verified site dimensions of the completed strengthening mass.

For typical Section Z-Z, the measurable volume shall be the volume of the new plum concrete foundation widening provided on both sides of the existing masonry foundation, within the approved block lengths, widths and depths. Existing foundation volume shall not be measured. Excavated volume shall not govern the payment volume unless specifically stated in the BOQ.

20.3 Inclusions in Rate

Although the measurement unit is Cum of completed foundation widening / jacketing, the quoted rate shall be deemed to include all operations necessary for safe and complete execution of the item, including temporary works and associated items. No separate payment shall be made for supporting operations unless separate BOQ items are specifically provided.

- Setting out, distress mapping, monitoring benchmarks and photographic records.
- Alternate block sequencing and restricted working lengths.
- Excavation in all types of soil within the strengthening scope.
- Dewatering, pumping and water diversion.
- Temporary shoring, propping and protection works.
- Cleaning and preparation of existing masonry foundation surface.
- Drilling, cleaning and anchoring holes.
- 12 mm diameter dowel bars and 16 mm diameter shear connectors as per drawings.
- Chemical anchoring / non-shrink anchoring grout.
- Plum concrete in 1:3:6 including stones and concrete matrix.
- Placement in two lifts, compaction, interface filling and curing.
- Backfilling, watering and compaction around completed blocks.

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- 40 mm thick guniting to masonry wall faces as specified/detailed for the strengthening section.
- 150 mm thick M15 RCC coping at ground/plinth level as specified/detailed for the strengthening section.
- Monsoon protection, rain covers, temporary drains and pumping.
- Scaffolding, barricading, lighting, safety measures and housekeeping.
- Testing, QA/QC records, as-built details and completion documentation.
- All leads, lifts, wastage, tools, tackles, labour, materials, machinery and incidental works.

20.4 Deductions and Exclusions

No deduction shall be made from the measured permanent strengthening volume for dowels, shear connectors, embedded bars, small pockets, minor irregularities or construction-stage holes. However, voids, honeycombed regions, rejected work or unapproved overbreak shall not be paid. Any additional concrete placed beyond approved lines without prior instruction shall not be measured.

If separate BOQ items are provided elsewhere for guniting, RCC coping, excavation or backfilling, then the Engineer may direct measurement under those separate items. However, where this comprehensive item is adopted, the rate shall be deemed inclusive as specified herein.

21.0 BOQ Item Description

The following BOQ description is recommended for direct insertion in the tender schedule.

Item No.	I-1
Description	Providing and executing strengthening of existing load-bearing masonry wall foundations by controlled alternate block underpinning, foundation widening and composite jacketing system as detailed in drawings and Section Z-Z, complete in all respects, including joint inspection, distress mapping, setting out of Zone-1 and Zone-2 blocks, temporary shoring/propping/bracing and all structural stability measures, controlled excavation in alternate blocks only, excavation in all types of soil, dewatering and water diversion, protection of open excavations, cleaning and preparation of existing masonry foundation, removal of loose mortar, vegetation, roots and deteriorated material, drilling holes in existing masonry foundation, providing and fixing 12 mm diameter dowel bars at 600 mm c/c or as shown in drawings, providing and fixing 16 mm diameter shear pins/connectors at 600 mm c/c both ways and both faces or as shown in drawings, cleaning drilled holes, fixing bars with approved chemical anchoring system/non-shrink anchoring grout, providing foundation widening on both sides of existing masonry foundation by plum concrete in 1:3:6 proportion with approximately 450 mm projection on each side and in two vertical lifts/blocks of approximately 600 mm + 600 mm or as detailed, proper placement and compaction around existing foundation to achieve composite action, repair/filling of local cavities and voids, selected earth backfilling with watering and compaction, providing 40 mm thick cement mortar gunite in 1:3 proportion to prepared masonry surfaces, providing 150 mm thick M15 RCC coping at ground/plinth level including formwork, reinforcement if detailed, placing, vibrating, finishing and curing, continuous curing of concrete/gunite/coping, structural monitoring, monsoon protection measures, scaffolding, barricading, warning signs, lighting, safety arrangements, disposal of surplus material, QA/QC documentation, photographs and all labour, materials, machinery, tools, tackles, leads, lifts, temporary works and incidentals complete as per specifications, drawings and directions of Engineer-in-Charge / Structural Consultant.

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Unit	Cum (Cubic Metre)
Mode of Measurement	Net completed volume of permanent foundation widening / foundation jacketing actually incorporated into the work and accepted by the Engineer, computed from approved drawings and verified site dimensions. Rate shall include all associated operations described above unless separately provided in the BOQ.

22.0 Contractor's Rate Deemed to Include

The Contractor shall be deemed to have included in his quoted rate all restrictions, precautions and obligations arising from the structural nature of the work. No extra claim shall be entertained on account of the following:

- Execution in Zone-1 and Zone-2 sequence instead of continuous working.
- Restriction on number of blocks open at a time.
- Reduction of block length ordered for structural safety.
- Additional care at corners, junctions, offsets and cracked locations.
- Temporary supports, shoring, bracing and emergency protective measures.
- Delay due to curing requirement before opening adjacent blocks.
- Dewatering, water diversion and monsoon protection.
- Cleaning and preparation difficulties due to old masonry and irregular foundation surfaces.
- Coordination with other repair, guniting, coping or strengthening works.
- Maintaining monitoring records and photographic documentation.
- Compliance with hold points and Engineer inspection requirements.

23.0 Engineer's Authority Clause

The Engineer-in-Charge / Structural Consultant shall have authority to interpret the drawings and this specification in the interest of structural safety. The Engineer may instruct changes in execution sequence, temporary support arrangement, block length, number of active blocks, waiting period, curing period, anchorage details, dewatering arrangements or local repair requirements based on site conditions.

Such instructions shall be followed immediately by the Contractor. Unless the instruction materially changes the permanent quantity beyond the approved scope, no extra payment shall be admissible for measures required to maintain safety and comply with this specification.

24.0 General Notes and Conditions

22. All work shall be carried out under competent supervision experienced in repair, rehabilitation and underpinning works.
23. The Contractor shall not commence work unless drawings, sequence and temporary support methodology are understood and approved.
24. Where existing foundation details vary from drawings, the Engineer shall be informed and revised instructions shall be obtained.
25. All proprietary materials shall be used strictly as per manufacturer data sheets and approved method statements.
26. The Contractor shall protect existing finishes, services, floors, drains, occupants and adjoining property.

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27. No heavy stacking of cement, aggregate, steel or stones shall be permitted near open excavations or weak wall portions.
28. Any deviation from drawing or specification shall require written approval.
29. Completion of the work shall include cleaning, removal of debris, reinstatement of working area and submission of records.
30. This specification shall be read together with structural drawings, general conditions of contract and other repair specifications in the booklet.
31. In case of ambiguity, the more conservative interpretation for structural safety shall apply.

25.0 Suggested Tender Schedule Summary

Item	Brief Description	Unit	Quantity	Rate / Amount
I-1	Foundation strengthening of existing load-bearing masonry wall foundations by alternate block underpinning, foundation widening and composite jacketing including all associated operations as per detailed BOQ description.	Cum	As per tender drawing / site measurement	To be quoted

26.0 Measurement Control and Site Recording Method

Since the BOQ unit is Cum, measurement control shall be maintained carefully. The intention is to measure the actual permanent volume of foundation widening / jacketing completed and accepted, and not merely the theoretical excavation volume. The Contractor shall therefore maintain block-wise dimensional records jointly with the Engineer.

For each completed block, the length, width/projection on each side, depth, lift details and any approved variation shall be recorded before backfilling. Photographs shall be taken with scale/measurement reference wherever feasible. The measurement sheet shall clearly distinguish permanent strengthening volume from excavation volume and from rejected/overbreak quantities.

- Length shall be measured along the wall/foundation block actually strengthened.
- Width shall be measured as the approved projection of new strengthening on each side of the existing foundation.
- Depth shall be measured as the actual approved vertical depth of permanent strengthening.
- Irregularities of existing masonry shall be measured on conservative practical basis as accepted by the Engineer.
- Unauthorized over-excavation or additional concrete placed for Contractor convenience shall not be measured.
- No deduction shall be made for dowels, shear connectors or embedded bars.
- Rejected honeycombed or defective work shall not be measured until rectified and accepted.

Where the completed strengthening differs from drawing due to site constraints, the revised dimensions shall be approved before concreting wherever possible. Measurement records shall be signed by Contractor representative and Engineer representative before the block is permanently concealed.

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27.0 Contractor Submittals Before Commencement

The Contractor shall submit the following documents for approval before starting the work. Submission and approval of these documents shall not relieve the Contractor from responsibility for safe execution.

32. Block-wise execution sequence drawing showing Zone-1 and Zone-2 order.
33. Method statement for excavation, temporary support, drilling, anchoring, plum concrete placement, backfilling, guniting and coping.
34. Dewatering and monsoon protection plan.
35. Temporary support / shoring proposal with sketches.
36. Material data sheets for chemical anchors / non-shrink anchoring grout, cement, steel and gunite materials.
37. Quality assurance plan including hold points and inspection formats.
38. Structural monitoring plan including crack and settlement observation method.
39. Emergency response plan for sudden crack development, water ingress, soil collapse or instability.
40. Safety plan for working near existing foundations and open excavations.
41. Daily reporting format and photographic documentation protocol.

28.0 Daily Execution Checklist

The following checklist shall be used by site staff for each active block. It is intended as a minimum control format and may be expanded by the Engineer depending on site condition.

Sr.	Checkpoint	Status / Remarks
1	Block number and zone marked at site before excavation.	
2	Adjacent blocks checked and confirmed not open.	
3	Temporary support / shoring arrangement provided where required.	
4	Existing cracks and monitoring points observed before excavation.	
5	Excavation carried out within approved block length and depth.	
6	No undercutting or loosening below existing foundation observed.	
7	Exposed masonry cleaned and loose material removed.	
8	Dowel and shear pin holes drilled to approved location and depth.	
9	Holes cleaned properly and anchoring material installed correctly.	
10	Dowel / shear pins checked for firmness and alignment.	
11	Lower lift plum concrete placed with proper compaction.	
12	Upper lift placed after approval and joint preparation.	
13	Curing arrangement started and maintained.	
14	Backfilling carried out only after approval.	
15	Photographs taken and daily log completed.	

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29.0 Final Completion Checklist

Before final acceptance of the item, the following completion checks shall be jointly reviewed. Payment certification may be withheld until the records are complete and the work is accepted.

- All Zone-1 and Zone-2 blocks completed in approved sequence.
- No unauthorized continuous excavation was carried out.
- All foundation widening/jacketing volumes measured and recorded block-wise.
- All dowel and shear connector installation records submitted.
- All photographs before, during and after execution submitted.
- Curing records for plum concrete, guniting and coping submitted.
- Monitoring records show no continuing distress attributable to the work.
- Backfilling and surface restoration completed.
- Guniting and coping completed to specified thickness/grade and accepted finish.
- Debris removed and site handed over in safe condition.
- As-built record of completed strengthening submitted.

End of Chapter I

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J

SPECIFICATION, METHODOLOGY, MODE OF MEASUREMENT & BOQ DESCRIPTION

Negative-Side Confined Basement Waterproofing System Between Existing Basement Structure and New RCC Jacket / RCC Protection Slab

Client / Project	Rajkot Nagrik Sahakari Bank Ltd., Parabazar Branch, Rajkot
Location	Rajkot, Gujarat
Prepared By	Manish V. Doshi, Consultant Structural & Civil Engineer, Rajkot
Document	Chapter I - Foundation Strengthening Specification
Measurement Unit	Cum (Cubic Metre)

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SECTION J (CONSOLIDATED)

Negative-Side Confined Basement Waterproofing System Between Existing Basement Structure and New RCC Jacket / RCC Protection Slab

SECTION J-1

Negative-Side Confined Basement Waterproofing System Between Existing Basement Structure and New RCC Jacket / RCC Protection Slab

Project: Rajkot Nagrik Sahakari Bank Ltd., Parabazar Branch, Rajkot
Prepared By: Manish V. Doshi, Consultant Structural & Civil Engineer, Rajkot

1.0 INTRODUCTION, BACKGROUND AND NEED FOR WATERPROOFING INTERVENTION

The basement forming the subject matter of the present rehabilitation scheme is an existing underground structure exposed to groundwater action, seasonal moisture variations and age-related deterioration. Investigations have indicated groundwater ingress, seepage, dampness and moisture migration. The waterproofing system is intended to become a permanent concealed component of the rehabilitation scheme and shall therefore be executed to standards significantly higher than ordinary building waterproofing.

2.0 ENGINEERING INTENT OF THE REHABILITATION SCHEME

The purpose of the waterproofing intervention is not merely to stop visible leakage. The intent includes prevention of groundwater ingress, reduction of moisture transmission, protection of structural components from continued deterioration, prevention of corrosion-promoting conditions and improvement of the basement environment. The waterproofing barrier shall form an integral component of the RCC rehabilitation system.

3.0 DESIGN PHILOSOPHY AND TECHNICAL BASIS

The waterproofing arrangement is based upon confined negative-side waterproofing. The membrane shall be installed against the existing substrate and subsequently enclosed by RCC protective wall and slab. The system shall function under permanent confinement, resist groundwater pressure, remain compatible with RCC jacketing and minimise concealed water migration.

4.0 HYDROSTATIC DESIGN BASIS AND WATER MIGRATION PHILOSOPHY

The basement waterproofing system shall be designed for approximately 8 m service groundwater head. The membrane system shall demonstrate tested hydrostatic resistance of not less than 12 m water head. Water migration control shall be treated as a primary design objective. The selected membrane shall provide hydrostatic resistance and effective control of lateral water movement.

5.0 REFERENCE STANDARDS AND ENGINEERING FRAMEWORK

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The work shall comply with IS 16471, IS 3067, IS 456, IS 3370 and relevant provisions of the National Building Code. Where Indian Standards are silent regarding confined waterproofing systems, internationally recognised standards and accepted engineering practice shall apply.

6.0 LIMITATIONS OF CONVENTIONAL WATERPROOFING APPROACHES

Ordinary roof waterproofing systems, damp-proof coatings, decorative coatings and similar products shall not be considered suitable for this project. Selection shall be based on demonstrated suitability for underground confined hydrostatic service conditions.

7.0 ACCEPTABLE WATERPROOFING SYSTEMS

Acceptable systems include bonded HDPE composite membranes, sodium bentonite geocomposite systems and specially designed SBS elastomeric composite membranes intended for confined underground waterproofing applications. APP membranes shall not be accepted.

8.0 CONTRACTOR'S RESPONSIBILITIES

The Contractor shall remain fully responsible for waterproofing performance irrespective of material approvals, inspections or testing. Waterproofing integrity shall be maintained throughout execution and coordinated with RCC jacketing operations.

9.0 SUBMITTALS, TECHNICAL DOCUMENTATION AND APPROVALS

Prior to commencement, the Contractor shall submit methodology, technical data sheets, performance test reports, installation drawings, quality plans, inspection plans and repair procedures for review and approval.

10.0 PRE-CONSTRUCTION INVESTIGATION AND BASEMENT CONDITION ASSESSMENT

A comprehensive condition assessment shall be carried out before commencement. Leakage mapping, crack mapping, identification of honeycombs, joints, penetrations and deteriorated areas shall be undertaken. A Basement Defect Register shall be prepared and approved before membrane installation.

SECTION J-2

Negative-Side Confined Basement Waterproofing System Between Existing Basement Structure and New RCC Jacket / RCC Protection Slab

Specification, Execution Methodology, Repair Requirements, Membrane Installation and RCC Interface Requirements (Clauses 11.0 to 20.0)

11.0 Surface Preparation Philosophy and Substrate Readiness Requirements

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Surface preparation shall be treated as a critical engineering activity. Existing plaster, coatings, loose mortar, laitance, unsound concrete and deteriorated masonry shall be removed. Surfaces shall be cleaned, regularized and approved before waterproofing commences.

12.0 Repair of Voids, Honeycombs and Open Joints

All voids, honeycombs, cavities and open joints shall be repaired prior to membrane installation. Waterproofing shall not be used as a substitute for substrate repair.

13.0 Crack Assessment and Crack Repair Methodology

Cracks shall be classified and treated according to their nature and behaviour. Active and water-bearing cracks shall be stabilized before waterproofing. Membranes shall not conceal untreated structural defects.

14.0 Fillet Formation and Geometric Corrections

Internal corners shall receive polymer modified cementitious fillets. Fillets reduce stress concentration, improve membrane continuity and reduce risk of leakage.

15.0 Membrane Installation Methodology

Installation shall proceed only after repairs and surface preparation are approved. Membrane continuity, lap treatment and repair of accidental damage shall be strictly controlled.

16.0 Pipe Penetrations, Sleeves and Service Entries

All penetrations shall receive enhanced detailing, collars and reinforcement strips as necessary to maintain continuity of the waterproofing envelope.

17.0 Lift Pit Waterproofing Requirements

Lift pits shall receive enhanced waterproofing treatment including additional detailing at corners, joints, penetrations and recesses.

18.0 Sump Pit Waterproofing Requirements

Sump pits shall be waterproofed continuously with special attention to pipe entries, pump penetrations and changes in level.

19.0 Construction Joint Treatment

Construction joints shall be identified, repaired and reinforced to prevent water migration and leakage.

20.0 RCC Jacket Interface Requirements

The waterproofing system shall remain functional under confinement between the existing structure and new RCC jacket. Membranes shall be protected during reinforcement fixing and concreting operations.

SECTION J-3

Negative-Side Confined Basement Waterproofing System Between Existing Basement Structure and New RCC Jacket / RCC Protection Slab

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QUALITY ASSURANCE, INSPECTION, TESTING, ACCEPTANCE CRITERIA, WARRANTY AND RISK MANAGEMENT (CLAUSES 21.0 TO 30.0)

21.0 WATER MIGRATION CONTROL PHILOSOPHY

One of the most misunderstood aspects of underground waterproofing is the distinction between visible leakage and concealed water migration.

The waterproofing system shall therefore be selected, detailed and installed with specific consideration for water migration control. The objective is not merely to resist hydrostatic pressure at isolated locations but to establish a continuous barrier that limits groundwater movement within concealed spaces.

22.0 REINFORCEMENT FIXING AND MEMBRANE PROTECTION

Many waterproofing failures occur after successful membrane installation but before placement of concrete. The membrane shall be protected from puncture, tearing, abrasion, displacement, contamination and accidental cutting. Any damage identified before concreting shall be repaired immediately.

23.0 MONSOON EXECUTION PROTOCOL

Waterproofing activities executed during monsoon conditions require special precautions. The Contractor shall prepare a dedicated monsoon execution plan and protect all partially completed work.

24.0 STRUCTURAL AND WATERPROOFING MONITORING DURING EXECUTION

Monitoring shall continue throughout execution. The purpose of monitoring is to identify new leakage, changes in leakage patterns, new cracking, movement of existing cracks, substrate deterioration and unexpected groundwater behaviour.

25.0 QUALITY ASSURANCE REQUIREMENTS

The waterproofing system shall be executed under a documented Quality Assurance and Quality Control framework. All inspections shall be documented and retained until final completion.

26.0 HOLD POINTS AND MANDATORY INSPECTIONS

Work shall not proceed beyond designated hold points without approval. Typical hold points include repairs, crack treatment, membrane installation, penetration detailing and pre-concreting inspection.

27.0 INSPECTION AND TESTING REQUIREMENTS

Inspection and testing form an integral part of the waterproofing quality programme. Inspection shall be continuous throughout execution.

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28.0 ACCEPTANCE CRITERIA

Acceptance shall be based upon overall system integrity. The Engineer shall have authority to reject any area considered unsatisfactory.

29.0 WARRANTY AND DEFECT LIABILITY REQUIREMENTS

The waterproofing system shall be supported by a written warranty from the Contractor for not less than ten years.

30.0 RISK REGISTER AND MANDATORY CONTROL MEASURES

The Contractor shall manage risks proactively including substrate preparation, crack treatment, lap treatment, penetration detailing, construction damage and monsoon exposure.

SECTION J-4

Negative-Side Confined Basement Waterproofing System Between Existing Basement Structure and New RCC Jacket / RCC Protection Slab

MODE OF MEASUREMENT, BOQ DESCRIPTION, CONTRACT CONDITIONS, COMPLETION REQUIREMENTS AND GENERAL PROVISIONS (CLAUSES 31.0 TO 38.0)

31.0 MODE OF MEASUREMENT PHILOSOPHY

The Consultant has intentionally adopted a simplified measurement philosophy. The waterproofing system shall be measured as a complete performance-based installation and not as a collection of individual operations.

Unit of Measurement: Square Metre (m²) of completed and accepted waterproofed area.

No separate measurement shall be made for surface preparation, leakage mapping, crack mapping, repairs, fillets, laps, overlaps, penetration treatment, testing, inspection, documentation, temporary works, scaffolding, access arrangements, material wastage, damage repairs or monsoon protection measures.

32.0 COMPREHENSIVE BOQ DESCRIPTION

Providing and executing complete negative-side confined waterproofing system to existing basement walls, floor slabs, lift pits, sump pits and associated underground structural surfaces including condition assessment, leakage mapping, crack mapping, cleaning, removal of unsound material, repair of cracks, repair of honeycombs, repair of voids, treatment of open joints, formation of polymer

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modified cementitious fillets, supply and installation of approved confined waterproofing membrane system, treatment of laps, corners, penetrations, sleeves, construction joints, lift pits, sump pits, terminations and changes in plane, protection during reinforcement fixing, protection during concreting, repair of accidental damage, quality assurance procedures, inspection, testing, photographic documentation, monsoon protection measures, preparation of records, rectification of defects before concealment and all labour, materials, equipment, tools, tackles, lifts, leads, temporary works and incidental operations complete.

33.0 CONTRACTOR'S RATE DEEMED TO INCLUDE

The Contractor's rate shall include investigations, substrate preparation, repairs, crack treatment, fillets, waterproofing materials, installation, testing, quality control, documentation, protection measures, temporary works, coordination with RCC works and all incidental costs.

34.0 ENGINEER'S AUTHORITY CLAUSE

The Engineer-in-Charge and Structural Consultant shall have authority to direct additional repairs, detailing, testing, protection measures, inspections and modified sequencing where necessary.

35.0 DAILY WATERPROOFING CHECKLIST

The Contractor shall maintain daily records of weather conditions, work completed, inspections, repairs, photographs and corrective actions.

36.0 FINAL COMPLETION CHECKLIST

All waterproofing areas shall be completed, inspected, documented and approved before final acceptance.

37.0 GENERAL NOTES AND CONDITIONS

Waterproofing integrity shall take precedence over construction convenience. No deviation from approved methodology shall be permitted without approval.

38.0 COMPLETION, HANDOVER AND TENDER SCHEDULE SUMMARY

The Contractor shall submit completion reports, inspection records, material certificates, warranty documents, testing records and rectification records before handover.

END OF SECTION J-4

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STRUCTURAL STEEL STRENGTHENING WORKS Specification, Methodology, Mode of Measurement & BOQ

(For RCC beam steel jacketing / underpinning, ISMB slab support, runner at slab-wall junction, and plan bracing diaphragm)

Issue: v1.0 | Date: 05-Feb-2026

Client / Project	Rajkot Nagrik Sahakari Bank Ltd., Parabazar Branch, Rajkot
Location	Rajkot, Gujarat
Prepared By	Manish V. Doshi, Consultant Structural & Civil Engineer, Rajkot
Document	Chapter I - Foundation Strengthening Specification
Measurement Unit	Cum (Cubic Metre)

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1. Scope of Work

This document covers the minimum technical requirements for supply, fabrication, erection and protection of structural steel strengthening works including:

- Structural steel jacketing of existing RCC beams and local underpinning/needle-beam support as shown on drawings.
- Supporting existing RCC slabs and/or beams by ISMB (or equivalent) sections, including bearing plates, stiffeners and end seating details.
- Providing continuous structural steel runner/channel/plate at slab-wall junction along masonry load bearing walls after completion of gunite jacketing, to achieve positive wall-to-diaphragm connection.
- Providing structural steel bracing in plan below slab to develop diaphragm action and distribute lateral forces into gunite-jacketed masonry walls.
- All steel-to-steel connections (welded/bolted) and steel-to-RCC / steel-to-masonry connections using post-installed fasteners as per drawings.
- Achieving 100% bearing/contact between steel and substrate using non-shrink grout/packing/shims as good engineering practice.

2. Design Responsibility & General Requirements

All member sizes, connection forces, weld sizes, anchor sizes/quantities, embedment depths, edge distances and spacing shall be as per approved structural drawings and design calculations issued by the Structural Engineer. The Contractor shall prepare shop drawings and method statements consistent with this document and site constraints.

Where existing substrate strength/quality is uncertain (aged RCC, weak/variable masonry, unknown mortar/brick type), proof/pull-out tests of chemical anchors shall be carried out and anchorage design shall be verified/updated prior to full-scale installation.

3. Reference Standards (Latest Revisions)

Unless otherwise specified, comply with the following (or approved equivalent international standards):

- IS 800: General Construction in Steel (Limit State Method).
- IS 2062: Hot Rolled Medium and High Tensile Structural Steel (material).
- IS 816 and IS 9595: Code of practice for metal arc welding of structural steel.
- IS 814: Covered electrodes for manual metal arc welding.
- IS 1367 / IS 1364 / IS 1363: Technical supply conditions and dimensions for bolts, nuts and washers.
- IS 456: Plain and Reinforced Concrete – for drilling, cover considerations and local repair.
- EOTA ETAG 029: Metal injection anchors for use in masonry (design/installation framework).
- EOTA TR 053: Job-site tests of metal injection anchors in masonry (pull-out/proof-load tests).
- EOTA EAD 330499 (Bonded fasteners for use in concrete) / manufacturer ETA or ICC-ES evaluation for bonded anchors.

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4. Materials

4.1 Structural Steel

- Rolled sections (ISMB/ISMC/ISA/plates/flats) shall be as per drawings and conform to IS 2062 (minimum grade E250 unless noted otherwise).
- Plates shall be straight, free from lamination and excessive pitting.
- All steel shall be supplied with mill test certificates and heat numbers traceable to certificates.

4.2 Welding Consumables

- Electrodes/wires shall be compatible with base metal grade and welding process, conforming to IS 814 and manufacturer recommendations.
- Welding shall be carried out by qualified welders with valid performance qualification records.

4.3 Bolts and Nuts

- Bolts/nuts/washers shall conform to relevant IS 1367/1364/1363; property class and diameter as per drawings.
- High-strength friction grip (HSFG) bolts, if specified, shall be installed with calibrated torque/tension control.

4.4 Post-installed Fasteners / Chemical Anchors

Provide only proprietary, tested two-component polymer-based injection mortars/adhesives suitable for the base material, with published load data and third-party approvals (ETA/ICC-ES or equivalent).

A) Steel to RCC (epoxy-grouted chemical anchors):

- Use epoxy or high-performance hybrid adhesive anchor systems approved for anchoring in concrete (cracked/uncracked as required) and suitable for the site temperature and installation conditions.
- Typical acceptable products (or approved equal): Hilti HIT-RE / HIT-HY series, fischer high-performance injection mortars, Sika AnchorFix series (subject to design and approvals).
- Anchor elements: threaded rods or rebar with grade, diameter and coating as per design (zinc plated / HDG / SS as required).

B) Steel to masonry load bearing wall (polymer-based chemical anchors):

- Use injection mortar systems approved for hollow and/or solid masonry with ETA for masonry (framework per ETAG 029 / EAD 330076).
- Typical acceptable products (or approved equal): Hilti HIT-HY 270 (hybrid mortar with ETA for masonry), fischer FIS V Plus (approved for masonry), Sika AnchorFix-3030 (suitable for hollow and solid masonry).
- Use perforated sieve sleeves/screen tubes for hollow/perforated masonry units; for solid masonry, direct injection may be used as per product approval.
- For uncertain masonry unit/mortar type or where ETA does not cover the exact substrate, carry out job-site tests and evaluate capacities as per EOTA TR 053 prior to bulk installation.

4.5 Bedding and Contact Grouting

- All bearing interfaces between steel and RCC/masonry shall achieve full, uniform contact.

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- Use pre-packed non-shrink cementitious grout (flowable/precision grout) for gap filling and bedding; comply with ASTM C1107 or equivalent. Minimum compressive strength 40 MPa at 28 days unless specified otherwise.
- Use steel shims/pack plates only where allowed by design; all voids behind shims shall be fully grouted.
- For thin gaps and surface undulations, use polymer-modified repair mortar/non-shrink mortar as directed by Engineer.

4.6 Corrosion Protection

- Unless otherwise specified: blast clean to Sa 2.5 (where feasible) or power-tool clean to St 3 for existing steel; remove oil/grease.
- Apply zinc-rich epoxy primer and compatible epoxy/polyurethane top coats to achieve total DFT as specified (typically 200–300 microns for internal severe exposure).
- All contact faces to be grouted may be left unpainted where required for bond; protect immediately after grouting.

5. Methodology / Method Statement

5.1 Pre-execution Checks and Planning

- Study structural drawings, strengthening scheme, connection details, tolerances and sequencing with the Project Engineer.
- Prepare detailed shop drawings and erection sequence drawings, including temporary works (propping/shoring) design and load path.
- Carry out condition survey (levels, deflections, cracks), and mark all proposed drill locations; confirm services/embedded items.
- Scan RCC members for reinforcement (rebar locator/ferroscan) before drilling; adjust hole locations to avoid cutting main bars.
- Confirm that gunite jacketing (where applicable) has achieved required curing and strength before drilling through it for runner anchors.

5.2 Temporary Propping / Load Transfer

- Provide engineered propping to safely relieve the existing member before cutting pockets, drilling, or installing steel supports.
- Props/needle beams shall be founded on sound substrates with spreader beams/sole plates.
- Monitor deflection/crack movement during propping and strengthening; stop work and inform Engineer if abnormal movement is observed.

5.3 Surface Preparation and Setting Out

- Remove plaster/paint/loose concrete and expose substrate as needed for proper contact and inspection.
- Dress contact surfaces by chipping/grinding high spots; clean dust and laitance.
- Mark centerlines, levels and reference points to maintain alignment and required camber (if any).

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5.4 RCC Beam Strengthening by Steel Jacketing / Underpinning

- Fabricate steel jacket components (channels/plates/angles/stiffeners) as per shop drawings; trial assemble where feasible.
- Lift and fit steel jacket around existing beam with adequate working clearance; ensure member is correctly aligned and supported.
- Provide shear transfer/holding brackets and post-installed anchors into RCC as per drawings. Drill holes with rotary percussion, avoiding rebar; clean holes by blow-brush-blow as per anchor manufacturer.
- Inject epoxy/hybrid adhesive and install threaded rods/rebar to required embedment; maintain correct projection and curing time before loading.
- Bring steel jacket into full contact using shims/packing and inject non-shrink grout to fill residual gaps; ensure continuous grout contact without voids.
- Complete welding/bolting of jacket seams, stiffeners and splice details; control heat input to avoid damage to existing concrete.
- Repair drill/pocket areas and exposed concrete with compatible repair mortar/micro-concrete after completion.

5.5 Supporting Existing Slab by ISMB (Needle Beam / Underpinning)

- Provide temporary propping to transfer slab load prior to installing ISMB supports.
- Form end seats/pockets in RCC or masonry as shown; provide bearing plates and leveling shims.
- Install ISMBs to line and level; check bearing length and clearance.
- Grout under bearings and between bearing plate and substrate with non-shrink grout to achieve 100% contact; cure as per manufacturer.
- Where specified, connect ISMBs to slab/beam using steel cleats and post-installed anchors to prevent slip and provide composite action.

5.6 Runner at Slab-Wall Junction on Gunit-Jacketed Masonry Walls

- After gunit jacketing is completed and cured, mark runner alignment and anchor locations along the wall.
- Drill through gunit layer and into underlying masonry to required diameter and depth; for brick/stone masonry, prefer rotary drilling (avoid excessive hammering) to prevent cracking.
- Clean holes thoroughly as per injection mortar manufacturer; install sieve sleeves for hollow/perforated masonry.
- Inject polymer-based injection mortar and install threaded rod/anchor; allow full curing before tightening nuts or applying load.
- Fix runner (channel/plate) with washers/nuts; ensure continuous bearing to wall by packing/grouting behind runner with non-shrink mortar/grout to eliminate voids.
- Provide corrosion protection touch-ups at cut edges and after installation.

5.7 Plan Bracing Below Slab to Develop Diaphragm Action

- Install bracing members (angles/flats/rods/ISMC) between ISMB supports and runners as per drawings to form in-plane triangulation.
- Provide gusset plates, cleats and stiffeners as detailed; ensure bracing lines are straight and free from unwanted eccentricities.

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- Where tension-only rods are used, provide turnbuckles and pre-tension to remove slack as specified; lock nuts after final adjustment.
- Complete welds/bolts and re-check alignment; ensure bracing does not clash with services and maintains specified headroom.

5.8 Inspection, Testing and Acceptance

- Welding: visual inspection for all welds; NDT (DPT/UT) for critical welds if specified by Engineer.
- Bolting: torque/tension verification for HSFG bolts using calibrated wrench; re-check after 24 hours if required.
- Chemical anchors in RCC/masonry: proof-load or pull-out tests at agreed frequency (minimum 1% of anchors or as directed). For masonry, evaluate results as per EOTA TR 053 when substrate is uncertain.
- Grouting: ensure proper mixing, flow and curing; check for voids and complete bearing contact.
- Prepare as-built drawings, anchor installation records, and material certificates for Engineer approval.

5.9 De-propping / Load Re-introduction

- Remove temporary supports only after anchors have fully cured and grout has achieved specified strength.
- De-prop gradually in stages, monitoring deflection/cracks; record final levels for reference.

6. Mode of Measurement

Unless the contract specifies otherwise, measurement shall be based on the following principles:

6.1 Structural Steel Work

- Measured in kilogram (kg) of fabricated and erected steel based on theoretical weight from approved shop drawings (IS section tables), including all plates, cleats, stiffeners, gussets, pack plates and bracing members.
- Rate shall include cutting, drilling, shop fabrication, trial assembly (if required), transport, hoisting, erection, alignment, welding, bolting, temporary tack welds and all consumables.
- Rate shall include surface preparation and paint system (primer + coats) unless measured separately.

6.2 Chemical Anchors / Fasteners

- If measured separately: measured in Numbers (No.) for each anchor of specified diameter and embedment, including drilling, cleaning, resin, threaded rod/rebar, sleeves (for masonry), fixtures, setting and curing.
- If included within steel item: no separate measurement; anchors shall be deemed included as per drawings.

6.3 Non-shrink Grout / Bedding Mortar

- If measured separately: measured in kilograms (kg) or bags as per manufacturer packing, or in cubic metre (m³) based on placed volume for bearing grout.
- If included: deemed included for all required full-contact bedding/packing.

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6.4 Testing and Documentation

- Proof/pull-out tests of anchors: measured per test (No.) including load application rig, reaction arrangement, gauges, calibration and reporting.
- NDT of welds: measured per metre of weld or per test as specified.

7. BOQ Item Descriptions (Typical)

Item 1: Structural Steel Strengthening System (Comprehensive)

Providing and fixing complete structural steel strengthening system including beam jacketing/underpinning, ISMB slab support beams, continuous runner at slab-wall junction on gunite-jacketed masonry walls, and plan bracing members below slab to develop diaphragm action, all as per approved structural drawings and specifications, including:

- Supply of IS 2062 steel sections/plates, fabrication, drilling, welding, bolting, stiffeners, gusset plates, cleats, pack plates and all accessories;
- Steel-to-steel welded/bolted connections;
- Steel-to-RCC fixing using post-installed epoxy/hybrid chemical anchors with drilling, hole cleaning, adhesive injection, threaded rods/rebar, nuts/washers and curing;
- Steel-to-masonry fixing using polymer-based injection mortar chemical anchors suitable for solid/hollow masonry with sieve sleeves where required, including drilling through gunite and into masonry, hole cleaning, adhesive injection, installation and curing;
- Achieving 100% bearing/contact by providing non-shrink grout / non-shrink mortar packing and shims as required, including bedding at end seats and behind runners;
- Surface preparation and corrosion protection painting system to specified DFT;
- All scaffolding, propping/temporary supports, safety measures, handling, alignment, testing, records and as-built documentation complete.

Mode of Measurement: kg of installed structural steel (complete system) OR as per contract schedule.

Rate to include all materials, labour, tools, tackles, consumables and incidentals to complete the work.

Item 2 (Optional): Proof/Pull-out Tests of Chemical Anchors

Carrying out proof/pull-out tests of installed chemical anchors in RCC/masonry including reaction arrangement, calibrated jack, gauge, loading protocol, recording load-displacement/ultimate load and reporting; complete as directed.

Mode of Measurement: No. of tests.

8. Notes and Engineering Good Practices

- Do not load anchors or remove props before adhesive full cure time (as per product datasheet considering ambient temperature).
- Maintain minimum edge distances and spacing to prevent masonry cracking and concrete splitting; adjust locations if required by rebar scanning and site constraints.

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- Use appropriate drilling mode: avoid heavy hammering in masonry; use sieve sleeves in perforated/hollow units.
 - Where steel bears on masonry/RCC, ensure adequate bearing length/area; rectify weak substrate by local rebuilding/patching before seating.
 - All deviations from drawings/specifications shall be approved by the Engineer in writing.

9. External Reference Documents (for anchor approvals)

The following publications are recommended for anchor selection, installation, and job-site testing (latest editions):

- Hilti HIT-HY 270 (ETA for masonry) – manufacturer technical documentation and ETA.
- fischer FIS V Plus – manufacturer technical documentation and ETA approvals for masonry and concrete.
- Sika AnchorFix-3030 – manufacturer data indicating suitability for hollow and solid masonry and concrete.
- EOTA ETAG 029 and EOTA TR 053 for design/testing of injection anchors in masonry; EOTA EAD 330499 for bonded anchors in concrete.

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SPECIFICATION, METHODOLOGY, MODE OF MEASUREMENT & BOQ DESCRIPTION

CONSULTANT SPECIFICATION, METHODOLOGY, MODE OF MEASUREMENT & SINGLE BOQ DESCRIPTION

NEGATIVE-SIDE CONFINED BASEMENT WATERPROOFING MEMBRANE SYSTEM WITH RCC JACKET / PROTECTION SLAB

Client / Project	Rajkot Nagrik Sahakari Bank Ltd., Parabazar Branch, Rajkot
Location	Rajkot, Gujarat
Prepared By	Manish V. Doshi, Consultant Structural & Civil Engineer, Rajkot
Document	Chapter I - Foundation Strengthening Specification
Measurement Unit	Cum (Cubic Metre)

Manish V. Doshi	Repair, Strengthening & Facelifting Specifications
Consultant Structural & Civil Engineer, Rajkot	Rajkot Nagrik Sahakari Bank Ltd. — Parabazar Branch

NEGATIVE-SIDE CONFINED BASEMENT WATERPROOFING MEMBRANE SYSTEM WITH RCC JACKET / PROTECTION SLAB

1.0 Scope and Intent

1.1 Scope

This specification covers remedial waterproofing of existing basement walls and floors from the internal (negative) side where the waterproofing membrane is installed between the existing basement structure and the proposed RCC jacket wall and RCC protection slab.

1.2 Intent

- Prevent groundwater ingress through walls, floor slabs, joints and penetrations.
- Provide a continuous confined waterproofing barrier.
- Achieve long-term durability under sustained hydrostatic pressure.
- Integrate waterproofing with proposed RCC jacketing works.

1.3 Exclusions

- External excavation and positive-side waterproofing.
- Structural strengthening design of existing basement.
- Settlement correction and movement-joint redesign.

2.0 Reference Standards

IS 16471, IS 3067, IS 456, IS 3370, ASTM D412, ASTM D624, ASTM D903, ASTM D1876, ASTM D5385, ASTM E154, EN 12311, EN 1928, ACI 515 and recognized international references where BIS provisions are silent.

3.0 Definitions

Negative-side waterproofing, confined waterproofing, blind-side membrane, hydrostatic head, crack bridging, peel bond, lap joint, active crack, dormant crack and water migration shall be interpreted in accordance with accepted waterproofing practice.

4.0 Pre-Repair Investigation

Mandatory joint inspection.

Leakage mapping.

Crack mapping.

Identification of damp zones.

Assessment of voids, honeycombs and deteriorated masonry.

NDT and sounding tests where directed.

Preparation of repair drawings and defect register before commencement.

5.0 Waterproofing System Selection

Acceptable systems:

- Bonded HDPE composite membrane.
- Sodium bentonite geocomposite membrane.
- SBS elastomeric composite membrane certified for confined waterproofing.

APP modified membranes shall not be permitted.

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Preference order:

1. Bonded HDPE composite.
2. Bentonite GCL.
3. SBS composite.

6.0 Material Performance Requirements

Design groundwater head: 8 m.

Minimum tested hydrostatic resistance: 12 m.

Preferred hydrostatic resistance: substantially greater than 12 m.

Minimum requirements:

Thickness ≥ 1.5 mm HDPE equivalent.

Tensile strength ≥ 25 MPa.

Ultimate elongation $\geq 500\%$.

Puncture resistance ≥ 1000 N.

Tear resistance ≥ 400 N.

Lap strength ≥ 1200 N/m.

Peel bond ≥ 1500 N/m.

Crack bridging ≥ 2 mm.

Dimensional stability $\leq 2\%$.

Design life ≥ 50 years.

Resistant to chlorides, sulphates and normal groundwater contaminants.

7.0 Storage and Handling

Materials shall be stored under cover, protected from moisture, sunlight, puncture damage and contamination. Damaged rolls shall be rejected.

8.0 Surface Preparation

Remove plaster, coatings, laitance, vegetation and unsound material.

Repair honeycombs and cavities.

Provide polymer modified repair mortar.

Correct irregularities exceeding 10 mm.

Provide 50 mm x 50 mm cementitious fillets at all internal corners.

9.0 Crack Treatment

Cracks < 0.3 mm: repair mortar.

0.3–2 mm: low viscosity epoxy injection.

> 2 mm dormant: epoxy injection plus repair mortar.

Active leaking cracks: polyurethane injection and stabilization.

10.0 Fillets and Junction Preparation

Wall-floor junctions, internal corners, lift pits and changes in plane shall receive fillets and additional reinforcement strips before membrane installation.

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11.0 Membrane Installation Methodology

Install membrane strictly as approved system.

Minimum lap 75 mm.

All laps welded/bonded/sealed.

Damaged membrane patched minimum 150 mm beyond damage.

Provide 300 mm reinforcement strips at corners, joints, penetrations, lift pits and sump pits.

Ensure continuity throughout waterproofed envelope.

12.0 Pipe Penetrations and Sleeves

Provide prefabricated collars, reinforced detailing strips and watertight sealing around all penetrations.

13.0 Construction Joint Treatment

Construction joints shall receive dedicated waterproof detailing compatible with membrane system.

Membrane continuity shall not be interrupted.

14.0 Lift Pit and Sump Treatment

Provide additional detailing, reinforcement strips and watertight continuity through all corners and changes in level.

15.0 RCC Jacket Interface

Waterproofing shall not rely solely upon adhesion to existing substrate.

Waterproofing shall remain functional by confinement between old structure and new RCC jacket/slab.

No reinforcement chair or shutter tie shall puncture membrane.

16.0 Quality Assurance and Hold Points

Hold Point 1 – Surface preparation.

Hold Point 2 – Crack repairs.

Hold Point 3 – Fillets.

Hold Point 4 – Membrane installation.

Hold Point 5 – Lap inspection.

Hold Point 6 – Penetration detailing.

Hold Point 7 – Reinforcement approval.

Hold Point 8 – Approval before concreting.

17.0 Acceptance Criteria

100% visual inspection.

Random seam testing at one test per 100 m².

No punctures.

No unsealed laps.

No discontinuities.

All defects rectified before RCC placement.

18.0 Records

Photographs before/during/after.

Material batch certificates.

Inspection checklists.

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Testing records.

Rectification records.

19.0 Warranty and Defect Liability

Minimum 10-year waterproofing warranty.

Leakage attributable to workmanship, detailing or membrane failure shall be rectified at contractor cost.

20.0 Leakage Rectification Procedure

Investigation, injection grouting, local opening, membrane repair, reinstatement and re-testing complete.

21.0 Mode of Measurement

Unit: Square Metre (m²).

Net accepted membrane area measured.

No separate payment for laps, overlaps, patches, strips, primers, adhesives, fillets, testing, QA/QC, repairs, wastage or accessories.

Openings >0.10 m² deducted.

Openings ≤0.10 m² not deducted.

22.0 Single BOQ Description

Providing complete negative-side confined waterproofing membrane system to existing basement walls and floors including investigation, surface preparation, hacking, cleaning, crack treatment, repair mortar, fillets, supply and installation of approved non-APP membrane system, treatment of laps, corners, penetrations, construction joints, lift pits, sump pits and terminations, inspection, testing, protection, rectification and all incidental works required to provide a complete watertight barrier prior to RCC jacketing/protection slab, complete as directed by Engineer-in-Charge.

23.0 General Conditions

Contractor shall submit method statement, shop drawings, material data sheets, QA plan and inspection plan before commencement.

24.0 Professional Limitation

This specification is intended for negative-side remedial waterproofing only. Structural movement, settlement, active movement joints and major structural deficiencies shall be separately investigated and addressed before waterproofing work proceeds.