ANNEXURE 3 SPECIFICATION

1 SPECIFICATION OF THE WORK OR PRODUCTS OR SERVICES REQUIRED

This section will cover the technical capabilities, constraints, and other specific performance required of the product or services to Demolish, Rehabilitate and Repair of **Cluster 3** (Wattles, India, Dallas, Katlehong and Lindela) PRASA footbridges in the Metrorail Gauteng Region for a period of eight (8) months.

PART A: GENERAL

1.1 PART A: GENERAL

1.1.1 INDEX

1.1.2 Miscellaneous

The project specifications form an integral part of the contract documents and supplement the standard specifications.

1.1.2.1 **Discrepancies**

In the event of any discrepancy with a part or parts of the standard specifications, the schedule of quantities or the drawings, the project specifications shall take precedence.

1.1.2.2 **Standard Specifications**

The standard specifications which form part of this contract have been written to cover all types of work normally associated with engineering contracts and they may therefore cover items not applicable to this particular contract.

1.1.2.3 **The Engineer**

"The Engineer" or his/ her deputy in terms of the contract documents shall be the person/s appointed by PRASA to carry out the duties of the Project Manager as defined in SPK5, the General Conditions of Contract.

1.1.2.4 **Further Information**

It is a further condition of Tender that PRASA reserves the right to call from any Tenderer for any further relevant information which information must be forthcoming within a stipulated period for the Tender to remain valid.

1.1.2.5 **Tender All-inclusive**

The Tenderer must allow in the tender for all labour, material, construction plant, temporary works, all taxes other than value added tax (VAT), levies and everything necessary for the execution and completion of the works in accordance with the tender documents.

1.1.2.6 **Extension of Time Resulting from Inclement Weather**

1.1.2.6.1 Extension of time resulting from abnormal rainfall or other forms of inclement weather shall be calculated according to the requirements of (Critical-path method).

1.1.2.6.2 The value of 'n' working days per calendar month as specified in this clause shall be as given in Table A below. If no abnormal rainfall other inclement weather periods occur during a specific calendar month (or months), then n-values as specified shall not be taken as accumulating over the contract period.

1.1.2.6.3 If the n-days allowed for in the programme of work are not taken up by standing time due to abnormal rainfall or inclement weather conditions, they will fall away and will not be considered in extension of time claims that may arise later during the contract period.

1.1.2.6.4 PRASA will provide the Contractor with a preliminary working program. The Technical Officer will also arrange for a depot planning meeting two (2) weeks in advance. This meeting will involve all the local stakeholders and production aspects of all work required for the rehabilitation and repair of various types of bridges in the Gauteng Metrorail Region will be discussed and recorded by means of the official meeting minutes.

Table A – Average ('n') delays due to inclement weather

Month	Jan*	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec*
'n' days delay	3	5	3	0	0	0	0	0	0	1	2	2
Rainfall (mm)	119	133	75	1	0	10	0	1	1	31	51	57

1.1.2.6.5 The value 'n' is the average number of days on which 10mm of rain has been measured by the weather station at Eendracht (Station No 0513314C9) over the last 9 years. Actual extensions of time due to inclement weather shall be agreed between the Project Manager and the Contractor on site.

1.1.2.6.6 The agreed whole days or parts thereof shall be recorded at the monthly site meetings and adjustments made to the contractor's representatives on the site. The agreed whole days or parts thereof shall be recorded at the monthly site meetings and adjustments made to the contract period on a monthly basis.

1.1.2.6.7 At the end of the contract, the Project Manager or delegated authority shall prepare a variation order to formalise the accumulated delays due to the inclement weather.

1.1.2.6.8 Approved extensions of time that extend the completion date beyond the start of the Contractor's holiday in December, the holiday period shall not be considered as working days. Any remaining extension of time at this date shall be calculated from the first statutory working day in January the following year, provided that the contractor has shown in their programme that they intend on closing during the traditional Christmas/ New Year break.

1.1.2.7 **Critical Path Method**

The critical-path method for determining extension of time resulting from abnormal rainfall shall be applied as follows:

1.1.2.7.1 A delay caused by inclement weather conditions will be regarded as a delay only if, in the opinion of the Project Manager or delegated authority, all progress on an item or items of work on the critical path of the working programme of the contractor has been brought to halt.

1.1.2.7.2 Delays on working days only (based on a five-day working week) will be considered for the extension of time, but the contractor shall make provision in his programme of work for an expected delay of 'n' working days caused by normal rainy weather, for which he will not receive any extension of time. The value of 'n' shall be given in the project specifications.

1.1.2.7.3 Extension of time during working days will be granted to the degree to which actual delays, as defined above, exceed the number on 'n' working days as mentioned in the project specifications.

1.1.2.8 **Duration of Contract**

The contract period for this project shall be eight (8) calendar months.

1.1.2.9 **Programme**

The Contractor shall provide a provisional construction programme with his tender. The programme must include a reasonable assessment of the number of occupation periods (measured in days) that will be required to complete work within a 3m range of the tracks and electrification. Programmes are required for tender adjudication purposed and may change during the course of the tender due to circumstances arising.

1.1.3 Description of the works

1.1.3.1 Locality of the project

The locality of the structures is shown below.

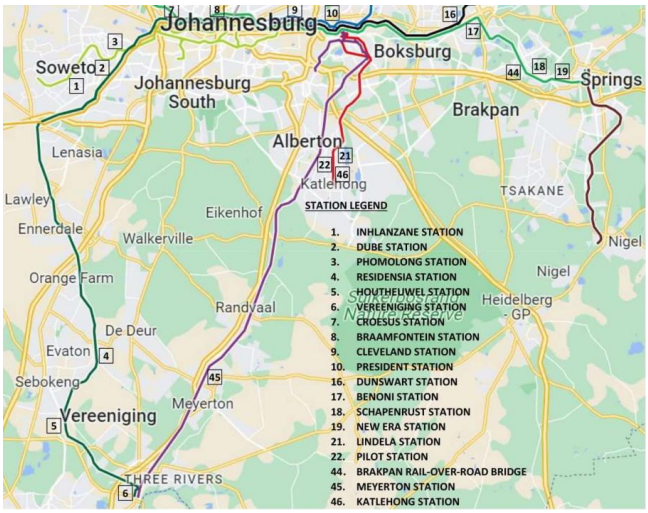


Figure 1: **Cluster 3** (Wattles, India, Dallas, Katlehong and Lindela)

1.1.3.2 **Limits of the Site**

The term “SITE” as defined in Clause 1.1 of the General Conditions of Contract, will comprise the railway reserve on each side of the existing tracks over 100m each side of each structure.
The term “site” shall be the sum of the individual sites at the following structures:

BRIDGE 1 Rail over Road Bridge/ Pedestrian

The “site” shall also include the following specific areas.

1.1.3.2.1 Crossroads and / or pedestrian ways within the rail reserve which pass over or under the above scheduled structures.

1.1.3.2.2 Land provided by the Employer where site offices are erected and where material for the works are stored.

1.1.3.2.3 Spoil sites

1.1.3.2.4 Any additional land that may be required for the proper completion of the contract.

1.1.3.3 **Access to the Site**

Structures are accessible from train station platforms and as suggested by the Project Manager or delegated deputy.

1.1.3.4 **Site Establishment**

1.1.3.4.1 The Contractor shall establish his/ her administration campsite within the railway reserve at location(s) that will be identified by the Project Manager at the site inspection.

1.1.3.4.2 The Project Manager’s approval must be obtained in writing for the establishment of any additional material depots and / or local site offices at other locations within the rail reserve.

1.1.3.4.3 At the end of the contract, all signs of the camp shall be removed from site and the site restored to its natural state. The camp area shall be topsoiled and grassed.

1.1.3.4.4 Provision for a Project Manager’s site office shall be made within the precincts of the Contractor’s campsite.

1.1.3.4.5 Important considerations in regard to the choice and approval of campsites and storage depots will be:

1.1.3.4.6 Public safety

1.1.3.4.7 Traffic obstruction

1.1.3.5 **Availability of Services**

The Contractor shall be responsible for arranging for the provision of services by the various service providers. The provision of services shall not be paid for separately and shall be deemed to be included in the applicable rates and sums under which the services are required.

1.1.3.6 **Availability of Construction Water**

Water for construction may be obtained from local sources including rivers. The Contractor shall be responsible for obtaining the necessary permission to draw water from the various authorities and landowners. Testing of the water is necessary before it is used for construction works and human consumption.

1.1.3.7 **Environmental Requirements**

An environmental Management Plan is not required for this Contract.

1.1.4 Scope of the Contract

The description of the project as provided in this section is merely an outline of the Contract Works and shall not limit the amount of work to be executed by the Contractor under this contract. Approximate quantities of the various types of work to be carried out in accordance with the contract documents are listed in the schedule of quantities bound in this volume.

The work includes, inter alia:

1.1.4.1 **Bridge 1 Wattles Station Steel Pedestrian bridge**

1.1.4.1.1 Determine the presence and extent of:

1.1.4.1.1.1 Concrete carbonation

1.1.4.1.1.2 Incipient reinforcement corrosion

1.1.4.1.1.3 Alkali / Silica reaction in concrete (ASR)

1.1.4.1.1.4 Concrete cover to reinforcement

1.1.4.1.2 Repair cracking and spalling concrete

1.1.4.1.3 Replace missing handrail sections.

1.1.4.1.4 Paint structural steelwork

1.1.4.1.5 Replace cracked and spalled deck planks.

1.1.4.1.6 Replace cracked and spalled stair treads.

1.1.4.1.7 Remove and replace asphalt surfacing.

1.1.4.1.8 Repair foundation plinths.

1.1.4.1.9 Repair concrete cracking and spalling.

1.1.4.1.10 Apply corrosion inhibitors and surface coatings to concrete as indicated by testing.

1.1.4.1.11 Work on the bridge structure will disrupt rail traffic and occupation working periods will be required.

1.1.4.1.12 Disruption to pedestrians will be minor and work can be carried out behind screens and / or off-peak periods.

1.1.4.2 **Bridge 2 India Station Steel Pedestrian bridge**

1.1.4.2.1 Determine the presence and extent of:

1.1.4.2.1.1 Concrete carbonation

1.1.4.2.1.2 Incipient reinforcement corrosion

1.1.4.2.1.3 Alkali / Silica reaction in concrete (ASR)

1.1.4.2.1.4 Concrete cover to reinforcement

1.1.4.2.2 Repair cracking and spalling concrete

1.1.4.2.3 Replace missing handrail sections.

1.1.4.2.4 Paint structural steelwork

1.1.4.2.5 Replace cracked and spalled deck planks.

1.1.4.2.6 Replace cracked and spalled stair treads.

1.1.4.2.7 Remove and replace asphalt surfacing.

1.1.4.2.8 Repair foundation plinths.

1.1.4.2.9 Repair concrete cracking and spalling.

1.1.4.2.10 Apply corrosion inhibitors and surface coatings to concrete as indicated by testing.

1.1.4.2.11 Work on the bridge structure will disrupt rail traffic and occupation working periods will be required.

1.1.4.2.12 Disruption to pedestrians will be minor and work can be carried out behind screens and / or off-peak periods.

1.1.4.3 **Bridge 3 Dallas Station Steel Pedestrian bridge**

1.1.4.3.1 Determine the presence and extent of:

1.1.4.3.1.1 Concrete carbonation

1.1.4.3.1.2 Incipient reinforcement corrosion

1.1.4.3.1.3 Alkali / Silica reaction in concrete (ASR)

1.1.4.3.1.4 Concrete cover to reinforcement

1.1.4.3.2 Repair cracking and spalling concrete

1.1.4.3.3 Replace missing handrail sections.

1.1.4.3.4 Paint structural steelwork

1.1.4.3.5 Replace cracked and spalled deck planks.

1.1.4.3.6 Replace cracked and spalled stair treads.

1.1.4.3.7 Remove and replace asphalt surfacing.

1.1.4.3.8 Repair foundation plinths.

1.1.4.3.9 Repair concrete cracking and spalling.

1.1.4.3.10 Apply corrosion inhibitors and surface coatings to concrete as indicated by testing.

1.1.4.3.11 Work on the bridge structure will disrupt rail traffic and occupation working periods will be required.

1.1.4.3.12 Disruption to pedestrians will be minor and work can be carried out behind screens and / or off-peak periods.

1.1.4.4 **Bridge 4 Katlehong station Steel Pedestrian bridge**

1.1.4.4.1 Determine the presence and extent of:

1.1.4.4.1.1 Concrete carbonation

1.1.4.4.1.2 Incipient reinforcement corrosion

1.1.4.4.1.3 Alkali / Silica reaction in concrete (ASR)

1.1.4.4.1.4 Concrete cover to reinforcement

1.1.4.4.2 Close road, install road signs and give advance warning to the general public.

1.1.4.4.3 Remove the existing asphalt surfacing.

1.1.4.4.4 Accommodate services and ensure that they are not damaged and continue to function when the deck is raised.

1.1.4.4.5 Break away concrete and free up the deck at the joints over the pier and abutments.

1.1.4.4.6 Support and jack up one bridge deck.

1.1.4.4.7 Install new spacer blocks on top of exiting supports to raise the deck slab.

1.1.4.4.8 Paint and refurbish the pier.

1.1.4.4.9 Raise the abutment curtain walls.

1.1.4.4.10 Reinstate concrete deck at end joints.

1.1.4.4.11 Seal joints

1.1.4.4.12 Repair damaged and spalling concrete.

1.1.4.4.13 Apply corrosion inhibitors and surface coatings to concrete as indicated by testing.

1.1.4.4.14 Paint steel parapet plates

1.1.4.4.15 Regrade the bridge approach embankment on both sides.

1.1.4.4.16 Apply new asphalt surfacing to bridge and approach embankment.

1.1.4.4.17 Reinstate services.

1.1.4.4.18 Reopen the bridge to traffic.

1.1.4.4.19 Rail traffic will be disrupted during jacking and some repair operations. Track occupations will be required.

1.1.4.4.20 Road and pedestrian traffic to adjacent facilities will be severely disrupted.

1.1.4.4.21 Temporary electrification supports will be required when the bridge deck is raised.

1.1.4.4.22 Disruption to pedestrians will be minor and work can be carried out behind screens during on and off-peak periods.

1.1.4.5 **Bridge 5 Lindela station Steel Pedestrian bridge**

1.1.4.5.1 Determine the presence and extent of:

1.1.4.5.1.1 Concrete carbonation

1.1.4.5.1.2 Incipient reinforcement corrosion

1.1.4.5.1.3 Alkali / Silica reaction in concrete (ASR)

1.1.4.5.1.4 Concrete cover to reinforcement

1.1.4.5.2 Close road, install road signs and give advance warning to the general public.

1.1.4.5.3 Remove the existing asphalt surfacing.

1.1.4.5.4 Accommodate services and ensure that they are not damaged and continue to function when the deck is raised.

1.1.4.5.5 Break away concrete and free up the deck at the joints over the pier and abutments.

1.1.4.5.6 Support and jack up one bridge deck.

1.1.4.5.7 Install new spacer blocks on top of exiting supports to raise the deck slab.

1.1.4.5.8 Paint and refurbish the pier.

1.1.4.5.9 Raise the abutment curtain walls.

1.1.4.5.10 Reinstate concrete deck at end joints.

1.1.4.5.11 Seal joints

1.1.4.5.12 Repair damaged and spalling concrete.

1.1.4.5.13 Apply corrosion inhibitors and surface coatings to concrete as indicated by testing.

1.1.4.5.14 Paint steel parapet plates

1.1.4.5.15 Regrade the bridge approach embankment on both sides.

1.1.4.5.16 Apply new asphalt surfacing to bridge and approach embankment.

1.1.4.5.17 Reinstate services.

1.1.4.5.18 Reopen the bridge to traffic.

1.1.4.5.19 Rail traffic will be disrupted during jacking and some repair operations. Track occupations will be required.

1.1.4.5.20 Road and pedestrian traffic to adjacent facilities will be severely disrupted.

1.1.4.5.21 Temporary electrification supports will be required when the bridge deck is raised.

1.1.4.5.22 Disruption to pedestrians will be minor and work can be carried out behind screens during on and off-peak periods.

1.1.5 Detailed description of the project

1.1.5.1 **Site**

The structures that are to be rehabilitated under this contract are situated over municipal roads and at PRASA train stations.

The contractor will be responsible to liaise with PRASA and the local authority when it is necessary to restrict the movement of road, rail traffic and pedestrian traffic.

1.1.5.2 **Traffic Volume**

Information relating to frequency of PRASA rail traffic will be provided to appointed contractor by the Project Manager:

Normal Occupation (Monday to Saturday)

- Daytime Peak Hours: 08:30am to 15:00pm
- Night Off Peak Hours: 19:00pm to 05:00am

Total Occupation (Monday to Friday)

- Daytime: 08:30am to 15:00pm
- Night-time: 20:00pm to 04:00am

1.1.6 List of Structures

1.1.6.1 **Cluster 3**

1.1.6.1.1 Wattles station steel footbridge

1.1.6.1.2 India station steel footbridge

1.1.6.1.3 Dallas station steel footbridge

1.1.6.1.4 Katlehong station steel footbridge

1.1.6.1.5 Lindela station steel footbridge

1.1.6.2 **Rehabilitation Works**

Details of the rehabilitation work on the structures, is listed in Clause 1.1.4.

1.1.6.3 **Drawings standards**

1.1.6.3.1 **General requirements**

To ensure adequate reproduction, drawings must comply with SABS 0111 and have:

1.1.6.3.2 **Standard drawing symbols**

The standard drawing symbols shown in SABS 0111 and in the E13 Specification for Engineering Survey Work must be used to indicate details on the drawings.

1.1.6.3.3 **Standard drawing sizes**

All drawings, including bending schedules, must conform to size A0 (841 mm x 1109 mm) with a margin of 25 mm in accordance with SABS 0111.

1.1.6.3.4 **Title block**

The following must be shown in the title block:

1.1.6.3.4.1 Section of railway line, e.g. “Meyerton – Katlehong”

1.1.6.3.4.2 Kilometrage of the bridge at the point of intersection.

1.1.6.3.4.3 Name of stations, streets, rivers, roads and /or farm names and numbers where relevant

1.1.6.3.4.4 Bridge and drawing numbers and other information required by the Project Manager or delegated authority.

1.1.6.3.5 **Space for Signatures**

An area of 150 mm wide by 200 mm high must be provided on the site plan and an area of 100 mm x 100 mm on the general arrangement drawing for the signatures of the Contractor’s Engineer and the Project Manager or delegated authority whose approval of the drawings is required. This area should be reserved immediately above the title block.

1.1.6.3.6 **Combined drawings**

The site plan and general arrangement drawing must not be combined as this results in unnecessary delay in approval and in the erroneous assumption that site plan approval includes approval of the general arrangement drawing.

1.1.6.3.7 **Content**

This drawing must show the following:

1.1.6.3.7.1 Plan, elevation, and cross section through the structure, showing an outline of the design with leading dimensions.

1.1.6.3.7.2 Horizontal and vertical clearances at tie points.

1.1.6.3.7.3 Method of construction of deep or piled foundations were located close to existing tracks.

1.1.6.3.7.4 Type of foundation to be constructed and nett loading intensity.

1.1.6.3.7.5 Method of construction of deep or piled foundations were located close to existing tracks.

1.1.6.3.7.6 Details of provisions to be made to attach overhead electrification equipment to deck soffits and sides, including bolt size and spacing and stainless-steel specification. Fittings must be shown for both present and future tracks.

1.1.6.3.7.7 An endorsement indicating the voltage and method of tensioning to which 1.1.6.3.7.6 applies.

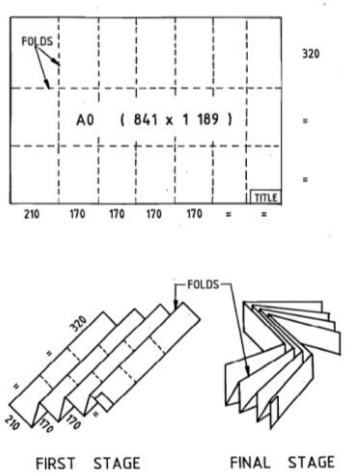
1.1.6.3.7.8 Position of holding down bolts for electrification masts in accordance with information given

1.1.6.3.7.9 Details of the loading for which the bridge will be designed, including the loading on the parapets and impact loading on the piers.

1.1.6.3.7.10 A space for a list of numbers and titles of all working drawings. On completion of the working drawings this list must be added.

1.1.6.3.8 **Submission**

Three (3) prints of the general arrangement drawing, signed by the relevant authority and/ or other parties involved, must be submitted to the Project Manager or delegated authority for approval by or on behalf of PRASA. Prints must be folded as shown below:



1.1.6.3.8.1 One set of prints of the working drawings, endorsed to the effect that they have been checked, and signed by the designer and by the Project Manager, where applicable, must be submitted to the Regional Engineer for approval. Prints must not be folded but forwarded in a roll together with the covering letter.

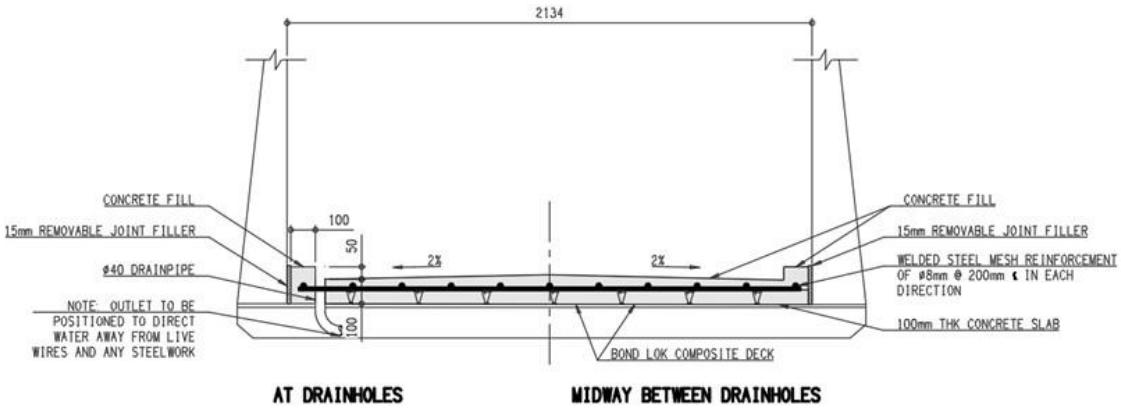
1.1.6.3.9 **As Built Drawings**

1.1.6.3.9.1 Working drawings must be amended to show details of the foundations as constructed and alterations, if any, made to the structure during construction, to represent an accurate record of

the structure as completed. As soon as possible after the completion of the structure(s), three complete sets of original hardcopies “as built” drawings in accordance with specification SABS 0111 must be forwarded to the Project Manager of delegated authority.

1.1.6.3.9.2 The Contractor shall furnish the Project Manager with all the “As built” information in an USB at the end of the Contract using PDF and DWG format.

1.1.6.3.9.3 The contractor shall follow instructions of preparing and submitting drawings to the Project Manager in accordance with Bridge Code: 1983, after acceptance of as built drawings, the associated intellectual property (designs and reports) and rights will be reserved by PRASA. Full ownership of designs and reports will be held solely by PRASA and used at PRASA’s own discretion.



Only dimensions measured by the contractor on site and agreed by the Project Manager shall be used for construction and measurement of quantities.

1.1.6.4 **Construction in confined areas**

1.1.6.4.1 It will be necessary for the Contractor to work within restricted and confined areas during fixed duration periods.

1.1.6.4.2 The tendered rates and amounts shall include full compensation for all special equipment and construction methods and for all difficulties encountered when working in restricted and confined areas.

1.1.6.4.3 Additional compensation will be paid for work done in confined area, provided that provision has been made in the standard specification and in the schedule of quantities.

1.1.6.4.4 If the provision has not been made in the schedule of quantities, it shall be included in the rate tendered for specific item and no extra payment shall be made nor shall any claim for additional payment be considered in such cases.

1.1.6.5 **Accommodation of traffic**

Accommodation of pedestrian and rail traffic will be required for all rehabilitation operations. Rail traffic control requirements are described in detail under (SPK 7/2 of the Standard Specifications). The Contractor must also take cognisance of the following:

1.1.6.5.1 The pedestrian and rail traffic shall have right of way and the Contractor shall take all the precautions that are necessary to ensure his personnel, equipment and vehicles do not infringe this right.

1.1.6.5.2 The Contractor may not commence work until the traffic accommodation measures related to that work as specified in (SPK 7/2) are installed and approved by the Project Manager or delegated authority.

1.1.6.5.3 The Contractor shall establish and maintain close co-operation with Gauteng Train Control Centre throughout the duration of this contract. Peak traffic periods shall be determined, and line closures shall be planned to avoid these times.

1.1.6.5.4 The Project Manager will invite a representative from Gauteng Metrorail Region shall be invited to attend all site meetings and the Contractor shall inform the Project Manager or delegated authority of all directives, advise and instructions that he/ she receives from the Gauteng Train Control Centre.

1.1.6.5.5 These directives, advises and instructions shall be implemented fully by the Contractor as part of the Contract.

1.1.6.5.6 Gauteng Metrorail Region shall have the authority to order the Contractor off a particular location of the site if public safety is compromised.

1.1.6.5.7 The Contractor shall maintain a continuous advance weather forecast for the duration of the contract and take all necessary steps to avoid traffic obstructions during inclement weather.

1.1.6.5.8 All signage must be visible 24 hours a day and must be maintained in place day and night for the duration of the contract.

1.1.6.6 **Changes to the scope of works**

1.1.6.6.1 It is a condition of this Contract that the Employer reserves the right to limit or extend the total expenditure on the Works due to possible budget variations and restraints. Should the tender Sum exceed the available budgeted amount, the scope of the Works may be reduced at any time before or during the Contract period to ensure that the final Contract amount does not exceed the available budget amount.

1.1.6.6.2 In the event that additional budget allocations are granted, structural steel repairs and painting of a structure similar to Bridges in this contract may be included in the Contract.

1.1.6.6.3 Only in the event that such adjustments or limitations occur after the award of the Contract shall they be deemed to be a variation of the form and quantity of the Works as envisaged in terms of Clause 31 of the General Conditions of Contract. The validity of the Tender or the individual rates and sums tendered shall not be influenced by any such adjustments or limitations other than those provided for in terms of Clause 31 and 36 of the General Conditions of Contract.

1.1.6.7 **Schedule of Works**

Structure Label	Cluster / Corridor	Reseal Joints	Access	Pedestrian & Traffic Control	Waterproofing concrete deck	Concrete Testing	Removal of existing concrete coatings	Application of corrosion inhibitor	Application of barrier coating	Application of carbon fibre strip reinforcement	Repair cracked and spalled concrete
1	Wattles	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	India	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Dallas	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Katlehong	✓	✓		✓	✓	✓	✓	✓	✓	✓
5	Lindela	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

1.1.7 Penalties

1.1.7.1.1 If the Service provider fails to complete the Services within the time as stipulated in this Contract for completion of Services or a part or portion of Services, the Contractor shall be liable to the Employer for an amount calculated at 0.03% of the Contract Price per delayed Day, which shall be paid for every day which shall elapse between the time for due completion and completion of the relevant Services.

1.1.7.1.2 However, the total amount due under this sub-clause shall not exceed the maximum of 10% of the Contract Price. The imposition of such penalty shall not relieve the Service provider from its obligation to complete Services or from any of its obligations and liabilities under the Contract.

1.1.7.1.3 PRASA may set off or deduct from the fees due to the Service provider any penalty amounts due and owing by the Service provider in terms of clause 1.1.7.1.1

The following penalties will be recovered from the Service provider for delays to PRASA trains as described above:

Each train R2500,00 per hour or part thereof - maximum of R22 500,00 per day.

1.1.7.1.3.1 Any missing released materials not accounted for will be deducted from the invoice according to following items:

R740.00 Per Wooden sleeper.

R970.00 Per Concrete sleeper.

R130.00 Per Chair.

1.1.7.1.4 Any missing released materials not accounted for will be deducted from the invoice according to the following prices:

R900.00 Per old, vandalized and faulty rail lubricator.

1.1.7.2 **Construction related security.**

1.1.7.2.1 Mandatory security requirements

1.1.7.2.2 All security companies used by the Service provider shall be PSIRA registered with Accredited letter of good standing.

1.1.7.2.3 Security personnel shall all be PSIRA registered with a clear criminal record no criminal pending cases and preferably be sourced from the local community.

1.1.7.2.4 All security officials utilised in this project shall be South African Citizens.

1.1.7.2.5 All personnel employed by the Service provider including sub-service providers shall have undergone a Health and Safety Induction.

1.1.7.2.6 Permits to work (in line with Covid-19 regulations) shall be issued at the cost of the service provider to all personnel on that shall be signed and stamped by the authorized PRASA Official responsible for Risk Management.

1.1.7.2.7 The security to be provided by the service provider shall be responsible for both the appointed service provider's assets and PRASA's assets on site until the site is handed over to PRASA. A list of all functioning equipment that do not form part of this scope of work will be shared with the successful bidder and shall be signed off by both the successful bidder and PRASA's representative.

1.1.7.2.8 PRASA assets that shall be guarded by the contracted security includes Permanent way assets, All Train Authorisation on track elements, all train stations (with all assets included) along the section and all functioning equipment along the corridor.

1.1.7.2.9 Any lost or stolen material shall be replaced by the service provider at his own cost.

1.1.7.2.10 The service provider shall provide on-site security for personnel and material stock and should ensure that patrols are in place at the section handed over to the service provider and until the completed work is handed over to PRASA. No claims of material or losses shall be lodged with

the client for stolen goods during the construction before the completed work is handed over to PRASA.

1.1.7.2.11 Furthermore, it is the service provider's responsibility to ensure that valuable metal i.e. Rail fastenings and turnout components are adequately protected while in transit to and from site.

1.1.7.2.12 The service provider shall make sure that all material removed from site is quantified, counted, logged in the site diary and that it is co-signed by a PRASA representative on site before it is removed from site.

1.1.7.2.13 Scrap metal removed from the section shall be adequately protected until it is delivered to PRASA's stores.

1.1.7.2.14 PRASA reserves the right to conduct ad-hoc inspections to ensure Compliance.

1.1.8 Risks

1.1.8.1.1 Tabulated below are the associated security Risks and proposed mitigation measures. It should be noted that these are minimum risks identified and bidders shall be responsible for conducting their own risk assessment that will influence their quotations.

Table H: Rail Related Risks

Risk	Probability	Mitigation
Project Hi-jacking – Regulation 9 30% Subcontracting. This includes the provision of security.	High	Social Facilitation to ensure community involvement and buy in. PRASA recommends an approach that involves the local community. Failure to ensure local involvement can result in serious work stoppages.
Theft of Installed equipment	High	Fit for purpose security with an integrated plan for assets installed and physical security at site office. Ensure protective measures for site with an access gate.

Hi-jacking of site personnel vehicles	High	Armed Escorts to and from the site
Armed Robbery of personnel on site and Storage Facility at site	High	Armed Guarding at site and site office with an armed response for mobilisation

1.1.8.2 **Proposed interventions**

Minimum of 2 vehicles with armed response officers (2-4) per vehicle strategically deployed within the site. To supplement the vehicles, a suitable number of day and night visible officers on foot patrol is required.

1.1.8.2.1.1 Requisite equipment

1.1.8.2.1.2 Bullet proof vests.

1.1.8.2.1.3 Spotlight.

1.1.8.2.1.4 Night vision equipment.

1.1.8.2.1.5 Torches.

1.1.8.2.1.6 Tactical Radios (PTT with GPS and Panic Button). This should be the primary communication for all personnel on site.

1.1.8.2.1.7 Handcuffs (disposable type) and other standard equipment.

1.1.8.2.1.8 Firearms with extra magazine; and

1.1.8.2.1.9 Any other equipment identified though the risk assessment.

1.1.9 Insurance

1.1.9.1.1 The Contractor shall provide proof of the “All Risk Insurance and Indemnity Insurance” with respect to himself/ herself, service providers, Principals, Associates, Specialist Service providers and staff and provide proof thereof that the specific Works in the PRASA environment are included, thereby indemnifying PRASA against all claims arising from consequential work performed by him/ her in this environment.

1.1.9.1.2 A statement of professional indemnity and insurance with supporting evidence and proof that the Contractor, Staff, and Works in the PRASA environment are included. Proof of insurance to be made available on request.

1.1.9.1.3 Site access certificate will not be issued prior to acceptance of proof thereof.

1.1.10 Overall Staffing and Key Related Professional Staff

The appointed Service provider will be required to provide qualified and experienced professional staff with the following key professional expertise:

1.1.10.1.1.1 Team Leader/Project Manager (Civil or Structural)

1.1.10.1.1.2 Civil / Structural Engineer

1.1.10.1.1.3 Civil Roads and Stormwater Engineer

1.1.10.1.1.4 Construction Health and Safety Officer

1.1.10.1.2 Professional body registration

1.1.10.1.3 Engineering Council of South Africa: Pr. Engineer/s, Pr. Technologist/s, Pr. Technician/s

1.1.10.1.4 South African Institute of Civil Engineers: SAICE

1.1.10.1.5 South African Council for the Project and Construction Management Professions: Pr. CPM, CPM and/or Pr. CM, CM and/or Pr. CHSA, CHSO and CHSM

1.1.10.1.6 Project Management Profession Certification: PMP

1.1.10.1.7 South African Council for Natural Scientific Professional SACNASP.

1.1.10.2 **Details of the minimum qualifications for the technical staff listed above are as outlined below.**

1.1.10.2.1.1 **Team Leader / Project Manager**

The desired minimum qualifications for the Team Leader/Project Manager are as follows:

1.1.10.2.1.2 BSc Degree/B-Tech Degree in Civil Engineering

1.1.10.2.1.3 ECSA registration as a Professional Engineer (Pr. Eng)/Technologist (Pr. Tech Eng). Minimum of five (5) years of post- professional registration experience in the Built Environment field of study with a minimum of five (5) years post professional registration experience in similar project disciplines in the Built Environment as a Project Manager.

1.1.10.2.2 Project Management qualification and over 5 years' post professional registration experience in Project Management.

1.1.10.2.3 South African Council for the Project and Construction Management Professions (SACPCMP) professional registration certification or Project Management

1.1.10.2.4 Professional (PMP) Certification with a minimum of five (5) years relevant post-certification practical experience.

1.1.10.2.5 Minimum of five (5) years post professional registration of leadership experience on similar or related projects.

1.1.10.2.6 Minimum of five (5) years' post professional registration experience in the planning and design of similar or related projects.

1.1.10.3 **Civil Engineer/ technologist (civil structural experience)**

The desired minimum qualifications for the Civil and structural Engineer/s are as follows:

1.1.10.3.1 BSc Degree/ B-Tech Degree in Civil Engineering.

1.1.10.3.2 ECSA registration as a Professional Engineer (Pr. Eng)/Technologist (Pr. Tech Eng).

1.1.10.3.3 Minimum of five (5) years post professional registration experience in Civil and Structural design including Construction Management experience.

1.1.10.3.4 Project Management qualification and over 5 years' post professional registration experience in Project Management.

1.1.10.3.5 South African Council for the Project and Construction Management Professions (SACPCMP) professional registration certification or Project Management Professional (PMP) Certification.

1.1.10.3.6 Minimum of five (5) years post professional registration experience on similar or related projects in a leadership role.

1.1.10.3.7 Minimum of five (5) years post professional registration experience in the planning and design of similar or related projects

1.1.10.4 **Civil Engineer (Roads and Stormwater)**

1.1.10.4.1 The desired minimum qualifications for Civil Engineer (Roads and Stormwater) are as follows:

1.1.10.4.2 BSc Degree/ B-Tech Degree in Civil Engineering.

1.1.10.4.3 ECSA registration as a Professional Engineer (Pr. Eng)/Technologist (Pr. Tech Eng).

1.1.10.4.4 Minimum of five (5) years of post-graduate experience in Roads and Stormwater Design including Construction Management experience with 5 years post professional registration.

1.1.10.4.5 Project Management qualification and over 5 years' experience in Project Management.

1.1.10.4.6 South African Council for the Project and Construction Management Professions (SACPCMP) professional registration certification or Project Management Professional (PMP) Certification.

1.1.10.4.7 Minimum of five (5) years of leadership experience on similar or related projects.

1.1.10.4.8 Minimum of five (5) years' experience in the planning and design of similar or related projects.

1.1.10.5 **Construction Health and Safety Agent (PRCHSA)**

The desired minimum qualifications for Health and Safety Agent are as follows:

1.1.10.5.1 B-Tech Degree in Safety Management.

1.1.10.5.2 Minimum of five (5) years post professional registration experience in Health and Safety including Construction Management experience.

1.1.10.5.3 South African Council for the Project and Construction Management Professions (SACPCMP) professional registration certification or Project Management Professional (PMP) Certification.

1.1.10.6 **Railway – Flagman**

The desired minimum qualifications for the Railway – Flagman are as follows:

1.1.10.6.1 Accredited recognized Railway – Flagman certification (valid at time of accessing site)

1.1.10.6.2 Minimum of three (3) years of experience

1.1.10.6.3 NB: A minimum of three qualified railway flag person shall be deployed for each occupied section.

1.1.11 To Be Provided by PRASA

1.1.11.1 PRASA Rail (in cooperation with the service provider) will arrange for the occupations during which the project will take place.

1.1.11.2 PRASA Rail will arrange and provide:

1.1.11.3 A Track Master to oversee the protection arrangements on site and to declare the track safe for the passage of trains during the work and on completion of work.

1.1.11.4 The following Rail materials will be provided by PRASA; Rails, Fastenings, and Detonators.

1.1.12 To Be Provided by Service Provider

1.1.12.1.1 The service provider shall in addition to what is stipulated in the Conditions of Contract, also supply the following:

1.1.12.1.2 A Site book (in triplicate) to record all incidents as well as the progress of work done during the occupation.

1.1.12.1.3 All equipment, tools, materials and labour that he/she shall need to successfully complete the project.

1.1.12.1.4 Supervision over and protection of the work site by qualified people.

1.1.12.1.5 Staff – with Accredited qualification for all types of work related to this Project.

1.1.12.1.6 The Service provider will have to ensure he/she is familiar with the specifications within this contract documents.

PART B: TECHNICAL SPECIFICATION

1.2 PART B: TECHNICAL SPECIFICATIONS

1.2.1 INDEX

1.2.2 Temporary Access for Bridge Rehabilitation

1.2.2.1 **Scope**

This specification covers the requirements for the provision of suitable and safe access to all areas requiring concrete demolition, repair work or rehabilitation in accordance with the contract, and for inspections by the Project Manager or delegated authority.

1.2.2.2 **Interpretation**

1.2.2.2.1 **Supporting Specifications**

The following specifications shall be read with and shall from part of the Contract:

1.2.2.2.1.1 Project Specification

1.2.2.2.1.2 SABS 1200A

1.2.2.3 **Definitions**

1.2.2.3.1 **Temporary works**

The temporary works necessary for access to the work area includes all foundations, scaffolding and support structures, working platforms, cradles, fixtures to existing structural members ,inter alia, required for the safe access to and execution of the work, and for the protection of passing persons, animals and vehicles and railway traffic against injury or damage and prevention of damage and littering to the environment.

1.2.2.4 **General Requirements**

The Contractor shall provide and will be responsible for safe access structures, shoring to excavations and work platforms to all areas requiring remedial work. The access and temporary works shall be designed, constructed and maintained in accordance with the current relevant safety regulations, all in compliance with the Occupational Health and Safety Act (Act 85 of 1993) and its applicable Regulations, and shall remain in place until removal is authorised by the Project Manager or delegated authority. Appropriate allowances shall be made for screening of the work and other protective measures required by the various work activities.

1.2.2.4.1 The Contractor shall submit to the Project Manager or delegated authority the relevant design details and drawings of the working platform(s) and access structures for comment, approval and/or record purposes.

1.2.2.4.2 Access and work platforms may be provided from overhead mobile access gantries or vehicles, or from temporary works supported from the ground or fixed to structural members. The design and erection/ construction of such temporary works shall be certified by a professional Engineer

on behalf of the Contractor to comply with the relevant safety regulations regarding strength and stability for all imposed loads that can be anticipated to arise from the specified work activities.

1.2.2.4.3 Structural certification of all access works shall be provided to the Project Manager or delegated authority before erection and / or use on site.

1.2.2.4.4 Notwithstanding approval given by the Engineer for the design and drawings prepared by the Contractor and the acceptance of temporary works including the working platform(s) and access structure(s) as constructed, the Contractor and his appointed Structural Engineer shall be solely responsible for the safety and adequacy of the temporary works and shall indemnify and keep indemnified the Employer and Engineer against any losses, damage to persons or property, all claims, demands, proceedings, damages, costs, charges and expenses whatsoever, which may arise out of or in consequence of the design, construction, use and maintenance of the temporary works.

1.2.2.4.5 For works on, over, under or adjacent to any railway line which is controlled by PRASA Metrorail, the Contractor shall comply, inter alia, with the requirements for the preparation and submission of drawings for false work and formwork, and the submission of certificates for the proper construction thereof, all in accordance with the latest SPK 7/2 specification.

1.2.2.4.6 The moving down a rope technique shall not be allowed.

1.2.2.4.7 The Contractor shall provide access facilities for inspection and testing by the Project Manager or delegated authority, including the inspection at the end of the maintenance period. Any period shall be as specified in the schedule of quantities.

1.2.2.5 **Material**

1.2.2.5.1 All timber, structural steel and scaffolding used shall be free from defects that may compromise the stability of the working platform(s) and access structures. The jacks, devices, clamps, and fittings shall all be in a good working order and of adequate design and strength.

1.2.2.5.2 The type, grade and condition of the material shall be subject to the Project Manager or delegated authority's inspection.

1.2.2.6 **Plant and Equipment**

1.2.2.6.1 **Mobile Access Units**

1.2.2.6.2 Access structures and work platforms mounted and operated from a mobile vehicular support base shall be of an approved type and capacity for the intended use.

1.2.2.6.3 The unit shall at all times be operated within the recommended limits in terms of reach and capacity as stated by the manufacturer or the authority responsible for the operation and maintenance of the access unit.

1.2.2.6.4 The Contractor shall, prior to dispatching the mobile access unit to the site, provide certification from the manufacturer of the operating authority that the unit has been thoroughly inspected and serviced, that the unit is functioning properly and that it complies with the relevant safety regulations.

1.2.2.6.5 **Scaffolds, Platforms and Cradles**

Temporary work entailing scaffolds, platforms and cradles providing access to the work area shall be assembled and constructed from materials and structural sections complying with the relevant approved design and specifications. The temporary works shall be designed, erected, operated, maintained, and dismantled so as to ensure the safety of all site personnel, pedestrians, road and rail traffic and where necessary the safety of the general public having access to the site.

1.2.2.7 **Construction**

1.2.2.7.1 All temporary access structures and work platforms and associated works shall be erected, modified, maintained, and dismantled under the direction of an experienced and competent supervisor or safety officer.

1.2.2.7.2 Prior to using any temporary access structures or facility, and at regular intervals thereafter, or following unforeseen circumstances, the temporary works shall be inspected and certified by a Professional Engineer appointed by the Contractor to design the access works.

1.2.2.7.3 To ensure the safety of, and to prevent injury or damage to passing persons, vehicles, animal, etc the temporary works shall be enclosed provided to assist in the removal of debris and unusable or rejected materials. Waste material shall not be left lying on the site.

1.2.2.7.4 Where temporary works are to be fixed to, or supported from existing permanent structure, the location shall be subject to the approval by the Project Manager or delegated authority. Such temporary works shall be removed when the work is completed and any holes, surface damage or blemishes arising from the fixture shall be repaired to the surface finish of the adjacent surface to the satisfaction of the Project Manager or delegated authority.

1.2.2.8 **Measurement and payment**

The payment items in this clause shall include full compensation for everything associated with the provision, maintenance, and removal of suitable and safe access to all rehabilitation and repair works and associated inspections.

1.2.2.8.1 **Temporary access structures and work platforms**

Provide access to working surfaces of: (Cluster 3: Wattles, India, Dallas, Katlehong, and Lindela)

1.2.2.8.1.1 Design, supply, erect and maintain access structures and work Platforms inclusive of dismantling, moving and re-erecting at various locations on the structure as required.

Item	**Unit**
	(Lump sum)

1.2.2.8.1.2 Dismantling and remove access structures and work platforms from site at end of work.

1.2.2.8.2 The unit of measurement for each sub item shall be a lump sum.

1.2.2.8.3 The tendered amount shall include full compensation for design, supply, fabrication, erection, dismantling, movement and for all labour, materials, and equipment required for the above works including the inspections, supervision by the safety officer and maintenance of the temporary access structure and work platform.

1.2.2.8.4 The amount shall also include for any additional temporary traffic accommodation required during the deployment and redeployment of the access equipment.

1.2.2.8.5 Payment shall be made on completion of each sub item.

1.2.3 Accommodation of road, rail, and pedestrian traffic

1.2.3.1 Scope

This section covers the accommodation of road, rail and Pedestrian Traffic on Metrorail property and adjacent environments.

1.2.3.2 General requirements

1.2.3.2.1 The Contractor shall be responsible for:

1.2.3.2.2 Safe passage of pedestrians

1.2.3.2.3 Safe passage of rail traffic by complying with the conditions of SPK 7/2 and all instructions and/ or warnings issued by Metrorail personnel.

1.2.3.2.4 Safe passage for vehicles and pedestrians on roads within and adjacent to the site.

1.2.3.2.5 The Contractor shall not commence any work until he/ she has complied fully with the requirements of SPK 7/2

1.2.3.2.6 The Contractor may accommodate pedestrian traffic at the structure while work is in progress provided that solid screen is erected between the pedestrian access way and the work area.

1.2.3.2.7 **Traffic Safety Officer**

The safety of the pedestrians, road traffic, rail traffic and Contractor's staff is of utmost importance and every effort must be made to ensure that all signs, flagmen and controls are maintained and effective and that courtesy is always extended to pedestrians.

1.2.3.2.8 The Contractor shall nominate an experienced and competent person on site who shall be the responsible person for the arrangements and maintenance of all accommodation of traffic measures required for the duration of the Contract. The responsible person shall liaise daily with the Project Manager or delegated authority.

1.2.3.2.9 The Contractor shall submit a CV of the proposed experienced competent person to the Project Manager or delegated authority for approval before he is appointed as the Traffic Safety Officer.

1.2.3.2.10 The Traffic Safety Officer shall be available to discuss traffic and pedestrian safety accommodation matters whenever required by the Project Manager or delegated authority. The traffic safety officer is to be a member of the Contractor's staff and **no additional payment will be made.**

1.2.3.2.11 The Traffic Safety Officer will be required to perform the following duties and this list shall not be deemed to be comprehensive:

1.2.3.2.12 Be responsible for the safe accommodation of road, rail and pedestrian traffic, 24 hours a day, 7 days a week.

1.2.3.2.13 Submit details of pedestrian and rail and road traffic accommodation proposals to the Project Manager or delegated authority for approval before they are implemented.

1.2.3.2.14 Personally inspect the pedestrian and rail and road traffic accommodation measures on the whole site of works twice each day, to ensure compliance and order remedial action, immediately if it its required. The Safety Officer shall keep a duplicate book for the specific purpose of recording irregularities and the remedied action taken.

1.2.3.2.15 The traffic safety officer shall be provided with all necessary staff and equipment to fulfil his/ her duties. She/ or He shall be directly answerable to the Contractors site agent. All construction vehicles used on site shall be equipped with visibility panels. The Traffic Officer shall have a direct line of communication at all times with the Project Manager or delegated authority.

1.2.3.2.16 All costs related to the provision of a safety Officer, assistant, staff and equipment shall be deemed to be included in the rates tendered for the Contractor's establishment on site.

1.2.3.2.17 Exercise control of the safe movement of personnel, visitors, pedestrians, road and rail traffic and plant on site including the wearing of high visibility clothing and the operation of direction and control equipment.

1.2.3.2.18 Be responsible for keeping all signs and equipment visible at all times.

1.2.3.2.19 Compile complete records of accidents, which are in any way connected with construction activities and draw up accident reports (including amongst other photographs).

1.2.3.2.20 Attend to the training and performance of flagman and all other personnel involved in the control of traffic and pedestrian.

1.2.3.2.21 Attend to all complaints and claims from the public with regard to traffic safety and report on such matters to the Project Manager or delegated authority.

1.2.3.2.22 Ensure that all obstructions related to the Contractor's activities be removed before nightfall where applicable and instructed by the Project Manager or delegated authority and that the roads and structures are safe for night traffic.

1.2.3.2.23 **Public traffic**

The Contractor shall plan the conduct of his activities so as to bring about the least possible disruption to pedestrian, road and rail traffic on the site on which he works.

1.2.3.2.23.1 **Accommodation of Pedestrian Traffic**

When bridges are being repaired the Contractor shall be responsible to take special precautions as directed below to provide safe temporary pedestrian access as follows:

1.2.3.2.23.1.1 Erect and maintain solid screens (not plastic or cloth) around work areas.

1.2.3.2.23.1.1.1 Ensure pedestrian access areas are free from material, rubble and equipment.

1.2.3.2.23.2 **Accommodation of Rail Traffic**

When carrying out concrete testing, concrete repairs and/or deck waterproofing closer than 3m to a track centreline the Contractor shall plan the conduct of his activities so as to comply with the following requirements:

1.2.3.2.23.3 Occupation of tracks

1.2.3.2.23.4 Between trains occupations are obtainable

1.2.3.2.23.5 Deployment of Flagmen etc.

Employ rail traffic control staff in accordance with the requirements of PRASA Specifications SPK 7/2

1.2.3.2.24 **Flagmen and Track masters**

1.2.3.2.24.1 At least one (1) track master and two flagmen shall be employed on the tracks to give warning and protection to the contract workers whenever work is being carried out within 3m of the centre of the track or overhead cables (3m measured from the centre of track to any temporary structure e.g. scaffold or tool held by a workman). (See SPK7/2 for details).

1.2.3.2.24.2 A track master and flagmen shall also be used under "Dead" conditions when the power is switched off.

1.2.3.2.24.3 Flagmen and track masters shall be on site and in position at all times that the

contractor is working and/or has occupation of tracks. Shift handovers shall take place on site, under no conditions shall the protection personnel leave the worksite unprotected. Flagmen and track masters shall be equipped with all necessary communication equipment and high visibility clothing. The contractor may arrange to have his staff trained and certified.

1.2.3.3 **Measurement and payment**

	Item	**Unit**
1.2.3.3.1	Provision Of Traffic Safety Equipment:	(Lump Sum)

The unit of measurement shall be a Lump Sum.

The tendered Lump Sum shall include for everything that is required to ensure the safety of the public, the Contractor's staff, and the PRASA staff for the duration of the contract including safety and communication equipment.

	Item	**Unit**
1.2.3.3.2	Media Releases and Public relations:	(Lump Sum)

The Lump sum is to cover costs related to public notices as instructed by the Project Manager or delegated authority. The tendered amount shall include full compensation for the handling costs and profit of the Contractor.

1.2.4 Survey and testing of surface concrete

1.2.4.1 **Scope**

This section covers the requirements to determine concrete cover to reinforcement, carbonation depth, half cell and resistivity testing for incipient corrosion and presence of alkali/ silica reaction within concrete members.

1.2.4.2 **General Requirements**

1.2.4.2.1 The test locations are shown in Annexure A. The contractor shall make allowance in his programme for the time required to carry out surveys, tests, and the reporting of results prior to commencing with repairs.

1.2.4.2.2 The contractor shall provide suitable and safe access to carry out the testing and enable the Project Manager or delegated authority to inspect the relevant concrete surfaces. General access requirements shall be measured and paid for under (Temporary Access).

1.2.4.2.3 Concrete Cover

1.2.4.2.4 The depth of concrete cover shall be determined by means of an approved electromagnetic cover meter. The cover meter shall be calibrated before being used on site. The validity of results

obtained from the cover meter survey shall be checked by direct measurement to exposed reinforcing bars.

1.2.4.3 **Carbonation Depth**

1.2.4.3.1 Samples of concrete may be removed from the structure or element by core drilling or by breaking out of a sample. Cores shall be split lengthwise, and the fractured surface tested. Phenolphthalein may also be used in situ on concrete surfaces freshly exposed by fracturing.

1.2.4.3.2 Sampling and testing shall be done on dry concrete surfaces. A cover meter shall be used to locate reinforcement and assist the extraction of cores without damage to the reinforcement.

1.2.4.3.3 A solution of 1% phenolphthalein in neutral ethyl alcohol shall be used as a pH indicator. This solution shall be sprayed onto a fresh concrete sample or exposed concrete surface. Phenolphthalein is colourless at a pH of 8.5 or less but has a pink to deep red colour at a pH of 9.0 or greater. Uncarbonated concrete therefore turns red when sprayed while carbonated concrete retains its original colour.

1.2.4.3.4 The phenolphthalein test solution must be obtained from an approved supplier and be stored in suitable sealed airtight containers.

1.2.4.4 **Half-cell And Resistivity Testing for Incipient Corrosion**

Half-cell and resistivity testing shall be carried out in the areas indicated to detect incipient corrosion.

1.2.4.5 **Alkali Silica Reaction**

Samples shall be taken by drilling and removing cores of concrete for testing at a suitably qualified laboratory for presence of alkali silica reaction in the concrete. All cores shall be wrapped, airtight, in plastic sheeting immediately after removal from the structure.

1.2.4.6 **Recording Of Results**

The contractor shall mark the position of each test on the structure and the location of each test shall be recorded on an approved reference drawing. Each test shall have a separate reference code. All cores shall be logged on the standard site core record sheets (Annexure B). Two copies of the test results shall be supplied to the Project Manager or delegated authority as soon as possible after testing is complete.

1.2.4.7 **Power Supply and Other Services**

The coring specialist shall make his own arrangements for the supply of electricity and all other services. No direct payments will be made for the provision of electricity and other services. The

cost thereof will be deemed to be included in the rates and amounts tendered for the various items of work for which these services are required.

1.2.4.8 **Coring in Confined areas**

It may be necessary for the Coring Specialist to work within confined areas. No additional payment will be made for work done in confined areas. The tendered rates and amounts shall include full compensation for all special equipment and construction methods required and for all difficulties encountered when working within confined areas, as well as at or around obstructions. No extra payment will be made, nor will any claim for additional payments be considered in such cases.

1.2.4.9 **Traffic Accommodation**

1.2.4.9.1 In order to core certain elements on this bridge, traffic may have to be deviated to accommodate hoisting equipment, coring machinery etc. In such circumstances, barricading of lanes shall only be done between the hours of 09h00 to 15h00 (during off-peak traffic), and a minimum of two lanes kept open to traffic at all times.

1.2.4.9.2 Under no circumstances shall the middle lanes be barricaded only. Only barricading of lanes by experienced competent sources will be allowed, and to be approved by the Project Manager or delegated authority.

1.2.4.9.3 No claims shall be considered. The Traffic Police of the Local Municipality must be consulted before any lane closure is done. The Contractor shall be responsible to negotiate all road deviation details and timing with the Local Municipality.

1.2.4.10 **Sealing of core holes**

All core holes shall be sealed with a Polymer Modified Cementitious Mortar to be approved by the Project Manager or delegated authority.

1.2.4.11 **Measurement and payment**

	Item	**Unit**
1.2.4.11.1	Concrete cover survey	m^2

The unit of measurement shall be the square metre of surface area of concrete surveyed by means of a cover meter. The tendered rate shall include full compensation for all labour, material and testing equipment required to execute the work and the recording of results.

	Item	**Unit**
1.2.4.11.2	Carbonation testing	Each (Ea.)

The unit of measurement shall be the number of carbonation tests carried out. The tendered rate shall include full compensation for all labour, material and testing equipment required to execute the work and the recording of results.

	Item	Unit
1.2.4.11.3	Testing for alkali silica reaction:	Each (Ea.)

The unit of measurement shall be the number of concrete cores that are extracted. The tendered rate shall include full compensation for all labour, material and equipment required to remove the cores and transport them to the laboratory, including all testing and reporting by an approved laboratory.

	Item	Unit
1.2.4.11.4	Half-cell and resistivity testing for incipient corrosion:	Square Metre (m^2)

The unit of measurement shall be square per metre of surface area of concrete tested. The tendered rate shall include full compensation for all labour, material and testing equipment to execute the work and the recording of results.

1.2.5 Waterproofing of Concrete surfaces

1.2.5.1 Scope

To provide a double layer of waterproofing membranes to concrete slabs with ballast and trackwork over, with Elastoplastomeric polymer or a similar approved material that contains an anti-root additive.

1.2.5.2 Surface preparation

Surface areas should be dry, clean, and sound, free for voids, sharp protrusions, or contaminants. Internal corners should be covered to 50mm and external corners radiused to 25mm. All surfaces, where the membrane is to be terminated, must be plastered to a smooth, true finish.

1.2.5.3 Priming

Prime all surfaces to be waterproofed with Bituminous Primer or similar approved, including all verges and around outlets and protrusions, then allow the solvent to flash off. Extremely porous surfaces should be reprimed.

1.2.5.4 Specification

1.2.5.4.1 Apply a 300mm wide gusset strip of Bituminous Primer, or similar approved, centrally at all deck and wall junctions.

1.2.5.4.2 Apply the first layer of Bituminous Primer, or similar approved, reinforced with 180g/m2 non-woven polyester membrane, 3mm thick. Fully bond the membrane, by heat fusion, onto the primed area. Side laps of 75mm shall be carefully sealed by heat fusion, allowing a small bead of molten bitumen to become visible at the exposed edge of the sheet. Seal these edges with a roller while the bitumen is still in a molten state. Do not seal these laps with a heated trowel of other tool, it does more harm than good.

1.2.5.4.3 For end laps, the underlying membrane must be heated to form a 100mm wide strip of molten bitumen. The underside of the upper sheet is also heated, laid into the molten bitumen, and sealed with a roller. Do not use a heated trowel to seal these end laps. Extend and fully bond the Bituminous Primer Plain, or similar approved, up all vertical surfaces and onto the top of surrounding upstands.

1.2.5.4.4 Apply the second layer of Elastoplastomeric Polymer Heat Fused membrane, or similar approved. Fully bond the membrane by heat fusion, onto the first layer. Laps to be in the middle of the first layer. Side laps of 75mm shall be carefully sealed by heat fusion, allowing a small bead of molten bitumen to become visible at the exposed edge of the sheet. Seal these edges with a roller while the bitumen is still in a molten state. Do not seal these laps with a heated trowel or other tool, it does more harm than good.

1.2.5.4.5 For end laps, the underlying membrane must be heated to form a 100mm wide strip of molten bitumen. The underside of the upper sheet is also heated, laid into the molten bitumen and sealed with a roller. Do not use a heated trowel to seal these end laps.

1.2.5.4.6 Apply a 5.5mm thick Polypropylene Board protective sheeting over all waterproofed surfaces before replacing backfill and ballast. All joints between the Polypropylene Board protective sheet to be taped.

1.2.5.5 **Testing**

On completion of the waterproofing installation, the Contractor is to seal all outlets and flood test the area. A certificate or letter is to be obtained from the Contractor establishing that the waterproofing treatment was handed over in a watertight and workmanlike manner.

1.2.5.6 **Measurement and payment**

The pay item for this Clause shall include full compensation for all work associated with the waterproofing of an existing bridge deck including initial preparation of concrete surfaces which are not already covered by measurement and payment items of the Standard Specifications of the Project Specification.

1.2.5.6.1 **Waterproofing of concrete surfaces**

Item	Unit
	Square Metre (m^2)

The unit of measurement shall be the square metre (m^2) of surface area waterproofed. The rate tendered shall include full compensation for all surface preparation, materials, plant, equipment, labour and incidentals required to execute the work as specified including the 5.5mm thick Polypropylene Board protective sheeting.

1.2.5.6.2 **Treatment of concrete surfaces**

Expenditure under this item shall be made on the instruction of the Project Manager or delegated authority to improve the concrete surfaces, if necessary, to a degree of smoothness and uniformity that will enable the waterproofing to be installed.

	Item	**Unit**
1.2.5.6.2.1	Treatment of concrete surfaces:	Lump Sum

1.2.6 Protective coatings and treatments for concrete

1.2.6.1 **Scope**

This section covers the material, equipment and work required for applying protective coatings and treatments to concrete surfaces.

1.2.6.2 **Interpretation**

1.2.6.2.1 **Supporting Specification**

The following specifications shall be read with and shall form part of the Contract:

1.2.6.2.1.1 Project Specification

1.2.6.2.1.2 SABS 1200

1.2.6.3 **Materials**

1.2.6.3.1 Penetrant Pore Liner (Water repellent surface impregnates)

Penetrant pore liners are low viscosity fluid which penetrate the concrete surface. After the concrete has been impregnated by one of these substances, the carrier fluid evaporates, leaving behind a hydrophobic (water repellent) layer in the pores of the concrete.

They are generally colourless and make little change to the appearance of the concrete.

Typical examples are silanes, siloxanes, silicon resins and stearates.

1.2.6.3.2 **Renderings**

Renderings are thick film coatings, generally applied by trowel rather than by brush or spray. They work in a similar way as coatings, by providing a physical barrier. Typical examples are cement mortar with various polymer additions and crystal growth systems.

1.2.6.3.3 **Corrosion Inhibitor**

Corrosion inhibitors are emulsion type impregnating fluid that is applied to the outer surface of existing concrete members. Inhibitors migrate into concrete and are absorbed onto the surface of embedded reinforcing steel thus delaying the onset of corrosion and/or reducing the rate of corrosion that is in progress.

1.2.6.3.4 **Coatings**

1.2.6.3.4.1 Coatings are viscous fluids that form a film on the surface of the concrete and provide protection as a result of the thickness of the film itself. They are usually pigmented to provide colour and extended or filled to provide thickness and surface texture to the coat.

1.2.6.3.4.2 Typical examples are epoxy resins, polyurethanes, alkyds, vynils, acrylics, chlorinated rubber, styrene-butadyne, bitumens and combination of these.

1.2.6.3.5 **Carbonation inhibitor barrier coatings.**

An approved carbonation inhibitor barrier coating shall comply with the following criteria:

1.2.6.3.5.1 Present a uniform appearance with the final colour to be decided by the Project Manager or delegated authority.

1.2.6.3.5.2 Provide barrier protection against ingress of water, oxygen, and carbon dioxide.

1.2.6.3.5.3 Permit the passage of water vapour.

1.2.6.3.5.4 Resist the deleterious effects of UV light.

1.2.6.3.5.5 Weather such that only minimal surface preparation is required when overcoating.

1.2.6.3.5.6 Adhere strongly to concrete and repair materials.

1.2.6.3.5.7 Bridge minor cracks and have flexibility to accommodate small movements.

1.2.6.3.5.8 Carry a 12-year guarantee against coating failure and UV degradation.

1.2.6.3.5.9 Be accompanied by a specification for surface preparation and application of overcoating after a 12-year period.

1.2.6.3.5.10 The product of the minimum dry film thickness of the coating (microns) and the carbon dioxide diffusion coefficient shall exceed 50-micron meters.

1.2.6.3.5.11 The cured coating shall reduce the water absorption of good quality 30MPa concrete by a factor of at least 20.

1.2.6.3.5.12 The product of the average dry film thickness of the coatings (microns) and the water vapour diffusion resistance coefficient shall not exceed 4-micron meters.

1.2.6.3.5.13 In the event that a multi-layer and/or a multi-product system is proposed the criteria (1.2.6.3.5.10), (1.2.6.3.5.11) and (1.2.6.3.5.12) shall apply to the complete system acting as a combined barrier coating.

1.2.6.4 Plant and Equipment

1.2.6.4.1 General Requirements

All plant and equipment used for pressure cleaning and protective treatment application shall be based on proven technology and practice and shall be maintained in a clean and good working order. The equipment shall be inspected, serviced, and calibrated at regular intervals and tested to ensure that the system functions efficiently and accurately, all to the satisfaction of the Project Manager or delegated authority.

1.2.6.4.2 High Pressure Water Jetting Equipment

The type and capacity of the water jetting equipment, delivery hoses and nozzles shall be capable of delivering water pressure through nozzles that will remove dirt, coatings, grime and staining from the concrete surface without producing an exposed aggregate finish.

1.2.6.4.3 Low Pressure Airless Sprayer

Low pressure airless sprayers consist of knapsack sprayers which shall be capable of providing a uniform discharge rate and even spread over the spray area.

1.2.6.4.4 Access Structures and Working Platforms

Where necessary the Contractor shall provide suitable and safe measures at each location for pressure cleaning and surface coating. The provisions shall be deemed to form part of the access for bridge rehabilitation.

1.2.6.5 Construction

1.2.6.5.1 Storing of Materials

The Contractor shall provide a lock up store for the repair materials and observe all storage requirements and safety precautions recommended by the materials manufacturers.

1.2.6.5.2 Surface preparation

1.2.6.5.2.1 Procedures

All concrete surfaces that are to receive protective coatings and/or treatments such as:

1.2.6.5.2.1.1 Penetrant pore liners

1.2.6.5.2.1.2 Renderings

1.2.6.5.2.1.3 Corrosion inhibitors

1.2.6.5.2.1.4 Coatings

1.2.6.5.2.1.5 Carbonation inhibitor barrier coatings

1.2.6.5.2.2 Shall be prepared strictly in accordance with the material manufacturer's instructions. The preparation shall include for everything that is necessary to prepare the surface to receive the protective coatings and/or treatments.

1.2.6.5.2.3 The Contractor shall ensure that technical representatives, appointed or employed by the materials suppliers, carry out regular inspections of the preparation work and provide written confirmation that the work is in accordance with the material supplier's requirements. The reports shall be specific and definitive, generalised statements will not be accepted.

1.2.6.5.2.4 Where surface preparation is found by the technical representative to be inadequate the report shall contain specific advice to enable the Contractor to attain a required standard.

1.2.6.5.2.5 The Contractor shall provide the Project Manager or delegated authority with copies of all technical inspection reports before any surface treatment or protective coatings is applied to a bridge element. Where the time between surface preparation and treatment exceeds two days and/or during windy and/or wet weather the prepared surfaces shall be reinspected and approved by the technical representative.

1.2.6.5.2.6 The moisture content of patch repair areas must be specifically checked by the technical representative to ensure that coatings are not applied over surfaces that contain moisture.

1.2.6.5.3 **Batching and Mixing**

1.2.6.5.3.1 Mixing equipment, mixing times, working life and overcoating times shall conform to the manufacturer's recommendations taking into account the temperature at time of application.

1.2.6.5.3.2 Treatment materials shall be mixed (if applicable) and applied strictly in accordance with the manufacturer's specifications. Thinning or diluting shall not be permitted without the approval of the Project Manager or delegated authority.

1.2.6.5.4 **Protective Surface Treatment**

1.2.6.5.4.1 Surface treatment or coatings may consist of a system of several coats of more than one type of coating. Where such a system is applied, the various components shall be compatible and preferably from one manufacturer.

1.2.6.5.4.2 Protective treatments shall be applied to all of the exposed concrete surfaces as indicated. Items or areas which are not to be coated, shall be suitably protected or masked before application of the treatment.

1.2.6.5.4.3 **Application of surface coatings**

All protective coatings and treatments for concrete shall be stored, mixed and applied strictly in accordance with the product manufacturer's specifications and the project specifications. All surface coating materials shall be handled, mixed and applied in accordance with the manufacturer's specification.

1.2.6.5.4.4 **Application rate records**

Records of application rates shall be submitted by the Contractor to the Project Manager or delegated authority on a daily basis indicating batch numbers, the area covered by each coat and the quantity of coating material used. Only material from the same batch shall be used for any continuous, visible, unbroken surface to attain uniformity of colour and texture on the concrete surface.

1.2.6.5.4.5 **Trail sample panels**

Protective treatment shall not be applied until trail sample panels of the protective treatment have been prepared by the Contractor and approved by the Project Manager or delegated authority and the material supplier's technical representative.

1.2.6.5.4.6 The Contractor shall prepare the sample panels using the same surface preparation mixing and batching equipment, application technique, application rate and under the same climatic conditions he/ she intends to treat the whole structure.

1.2.6.5.4.7 The position of the trail sample panels are subject to the Project Manager or delegated authority's approval. Product manufacturers of coating products are required to inspect, assist, and finally approve (in writing) all aspects of surface preparation and product application employed on the trial sample. The trial sample shall be used as a standard which the rest of the work will be judged and shall be maintained intact until all other coating is complete.

1.2.6.5.4.8 **Proprietary protective surface coatings**

The suitability of the protective surface coating for a particular application shall be proved by testing and submission of an approved industry track record of usage under similar circumstances. The Contractor shall submit details of proprietary protective surface coatings to the Project Manager or delegated authority for approval prior to its use in the permanent works.

The surface coating systems shall be:

1.2.6.5.4.8.1 Penetrant pore liners: Water Repellent

1.2.6.5.4.8.2 Renderings: Polymer modified mortar

1.2.6.5.4.8.3 Corrosion inhibitors: Corrosion Protection

1.2.6.5.4.8.4 Carbonation inhibitor Barrier coating: Exterior high build coating or similar approved materials.

1.2.6.5.4.9 **Health and Safety Precautions**

The Contractor shall observe the health and safety precautions recommended by the manufacturer regarding the handling and the disposal of unused material and containers. The Contractor shall ensure that natural water streams or rivers are not polluted by protective treatment material under any circumstances.

1.2.6.6 **Testing**

The Contractor shall ensure that only compatible materials are used for the surface treatment or protective coatings. The test results shall be reported to the Project Manager or delegated authority and will be subject to approval.

1.2.6.7 **Measurement and payment**

Payment for items in this section shall include full compensation for all works associated with the execution of the work and quality assurance procedures which are not separately covered by the measurement and payment items of the Standard Specifications and the Project Specifications. All work and materials for which no specific pay item is defined shall be deemed to be covered by the items of this section.

	Item	**Unit**
1.2.6.7.1	Cleaning and preparation of concrete surfaces: (Method and surface finish indicated)	square metre (m^2)

The unit of measurement shall be the square metre (m^2) of surface area cleaned by the method indicated.

The rate tendered shall include full compensation for all material, plant and equipment, all labour and incidentals required to execute the work as specified.

	Item	**Unit**
1.2.6.7.2	Application of protective treatments: (Type and application rate indicated)	square metre (m^2)

For payment purposes, the surface area shall be measured once only irrespective of the number of layers of protective coatings and/or applications of surface treatment is required to achieve the specified application rate.

The tendered rate shall include full compensation for all surface preparations, (specified by the product manufacturers including high pressure water if required), labour, materials, equipment, additional safety measures, storage, mixing and applications of the protective coatings and treatments, cleaning and disposal of unused or rejected material and all incidentals necessary to execute the work (including wastage) as specified, to all the satisfaction of the Project Manager or delegated authority.

1.2.7 Demolition and removal of structural concrete and steel members

1.2.7.1 **Scope**

This specification covers the work in connection with the demolition of entire members of a concrete structure as well as cutting back concrete to expose reinforcement and the initial preparation of the exposed surface. Surface and structural repair of concrete members is covered in Project Specifications.

1.2.7.1.1 **Supporting Specification**

The following specification shall be read with, and form part of the Contract:

1.2.7.1.2 **Definitions**

1.2.7.1.2.1 **Concrete members**

All references to concrete members shall include mass concrete, unreinforced, reinforced, and prestressed concrete members.

1.2.7.1.2.2 **Demolition of concrete members**

Demolition means the breaking up and removal of an entire concrete member.

1.2.7.1.2.3 **Removal of concrete**

Removal of concrete means cutting back into the surface or end of a concrete member and the removal of unsound, damaged, or contaminated concrete, or the partial removal of concrete sections, to expose a sound surface for bonding new material for the repair or extension of the concrete member.

1.2.7.2 **Materials**

All devices used to remove concrete or to demolish concrete members, shall be handled, stored and used strictly in accordance with the manufacturer's instructions and current safety regulations.

1.2.7.3 **Plant and Equipment**

1.2.7.3.1 **General**

All plant, equipment, tools and devices used for the demolition of concrete members or the removal of portions of existing concrete shall be based on proven and accepted technology within the industry.

1.2.7.3.1.1 The plant, equipment, tools, and accessories shall be inspected and maintained on a regular basis to ensure that they remain in good working order, function efficiently and the safety is not compromised. All cutting and breaking tools shall be kept sharp to reduce the force required to break out concrete to a minimum.

1.2.7.3.1.2 The plant, equipment, tools, and devices used for the demolition or removal process shall be of the accepted type and capacity for the relevant application. The suitability of the chosen method shall be demonstrated on a representative test section identified by the Project Manager or delegated authority prior to the execution of any programmed work.

1.2.7.3.2 **Access Structures and Working Platforms**

Where necessary, the Contractor shall provide suitable and safe temporary access structures, working platforms, debris collection and removal chutes and bins, including protection screens where required, at each location where concrete must be demolished or removed.

The temporary structures, platforms, chutes, etc. must be stable and of sufficient strength and rigidity to safely carry the imposed temporary loads arising from the work activity, all as described in Project Specification.

1.2.7.4 **Construction**

1.2.7.4.1 **Sequence of Execution**

The method and sequence of demolition or removal of concrete shall be in accordance with the drawings or as directed by the Project Manager or delegated authority and the approved method statement submitted by the Contractor following preconstruction testing if necessary.

Any temporary propping specified in the approved method statement and the drawings shall be securely positioned in accordance with each stage of the demolition or removal sequence prior to commencement of the following stage.

1.2.7.4.2 **Site Preparation and Access**

The necessary access and temporary support structures shall be in place prior to the commencement of demolition or removal of concrete. Screening and protective measures shall be established around the work area as necessary to ensure acceptable environmental, health and safety conditions.

1.2.7.4.3 **Demolition of Concrete Members**

1.2.7.4.3.1 The demolition of entire concrete structures or major elements of a structure shall employ techniques that do not damage adjacent structures or structural elements, are not a danger to public safety, nor contaminate the surrounding environment except during special periods as may be approved by the Project Manager or delegated authority.

1.2.7.4.3.2 The Contractor shall ensure that any nuisance associated with his work activity is minimised by implementing appropriate precautions and measures to the approval of the Project Manager or delegated authority. Common nuisances associated with demolition and concrete removal include fumes, noise, dust, flying fragments, head, and vibration.

1.2.7.4.3.3 Concrete members which are to be demolished completely shall be broken into suitably sized fragments to allow easy removal from site to an approved dump area.

1.2.7.4.3.4 Recommended demolition techniques include the use of percussion breakers, chisels or other approved mechanical equipment, the use of thermal or hydraulic cutting techniques or by non-explosive chemical means, to ensure minimal damage (e.g. micro cracking) to the existing concrete. Demolition by explosive means will normally not be acceptable and will be subject to the Project Manager or delegated authority's written approval. Water jet removal of concrete is preferred wherever feasible.

1.2.7.4.4 **Removal of Concrete from Structural Elements**

1.2.7.4.4.1 **Cutting back concrete to a new finish surface**

1.2.7.4.4.2 The concrete and reinforcement shall be cut back adequately to provide the prescribed concrete cover to the new finished surface as indicated on the drawings or as prescribed by the Project Manager or delegated authority. The techniques used shall be suited to its intended purpose and shall not cause damage to the remaining concrete member.

1.2.7.4.4.3 Only techniques that do not damage the inherent structure, bond or strength of the remaining sound concrete shall be used. The thermal cutting technique shall not be used closer than 100mm for the final surface as indicated on the drawings. The remaining concrete shall be removed using approved mechanical equipment or hydraulic techniques.

1.2.7.4.4.4 The fixed exposed contact surface shall be bounded by straight line edges cut at least 10mm deep by a diamond cutting saw, angle grinder or other approved equipment.

1.2.7.4.4.5 **Cutting back concrete to expose reinforcement.**

1.2.7.4.4.6 Where a concrete member has to be joined or extended or replaced by new concrete, the concrete shall be carefully cut or broken from the reinforcement to expose the bars to the dimensions and outline as shown on the drawings or as directed by the Project Manager or delegated authority. Care shall be taken not to damage or reduce the strength of the exposed bars or concrete member thereby making them unfit for use. The remaining concrete contact surface shall be cut to a plane and even surface with exposed faces perpendicular to the horizontal face or side faces as applicable.

1.2.7.4.4.7 The bounding lines of the cut concrete shall be straight and neat cut to at least 10mm depth using a diamond cutting saw, angle grinder or other approved concrete cutting equipment.

1.2.7.4.5 **Removal of Metal Sections Embedded in Concrete**

1.2.7.4.5.1 Metal sections that are embedded in concrete members by means of grout pockets shall be removed by carefully chipping out the embedded grout filling the pocket. Care shall be taken not to damage the structural concrete surrounding the pocket. Suitable tools such as hand held power tools with chisel bits or hand tools shall be used.

1.2.7.4.5.2 Following the removal of the metal sections, all remaining grout shall be removed and the pocket cleaned out to expose only solid concrete surfaces. The pocket shall be finally cleaned using high pressure water jetting or oil free compressed air to remove all loose fragments of grout, or concrete aggregate.

1.2.7.4.6 **Preparation of Exposed Concrete Surfaces**

(For extension of existing concrete elements or construction of new concrete members)

1.2.7.4.6.1 All loose and shattered concrete, as well as foreign material such as oil, paint, grease etc. shall be removed from the contact surface of old concrete before new concrete is placed. The aggregate must be exposed to provide a good bonding surface.

1.2.7.4.6.2 The mechanically prepared concrete surface shall be cleaned by means of oil free compressed air or water jetting.

The breaking out and preparation of damaged, spalled and/or cracked concrete surfaces is described and measured under Schedule of quantities.

1.2.7.4.7 **Joining New Work to Old**

1.2.7.4.7.1 Where partial demolition is required for extension work to existing structures, the contact face shall be cut to predetermined lines and levels, any loose and fragmented material shall be removed, and projecting steel cleaned and bent as directed by the Project Manager or delegated authority. Where partial demolition is not required but extension work only, the contact surface shall be roughened and cleaned of all dirt and loose particles.

1.2.7.4.7.2 If dowels are required, they shall be installed in holes drilled into the existing structure, in accordance with the details shown on the drawings and secured by means of an approved type of epoxy resin grout.

1.2.7.4.8 **Disposal of Waste Material**

All waste materials, rubble, scrap, and rubbish arising from the Contractor's presence on site and/or the execution of the works shall be disposed of weekly to a disposal site identified by the Contractor and approved by the Project Manager or delegated authority. The Contractor shall furnish Project Manager or delegated authority with a certificate of disposal from a registered dump site.

1.2.7.5 **Tolerances**

The Contractor shall remove concrete to a plain, uniform surface with 25mm maximum deviation from the level or dimension indicated on the drawings unless otherwise approved by the Project Manager or delegated authority. The outer edge of the contact surface shall consist of straight lines with maximum deviation of 5mm from straight, measured with a 1m long straight edge and shall be within 5mm of the position indicated on the drawings, or as approved by the Project Manager or delegated authority.

1.2.7.6 **Testing**

The Contractor shall carry out preconstruction tests with the proposed equipment to determine the suitability of the technique for the envisaged application. The test results shall be reported to the Project Manager or delegated authority and shall be subject to approval.

1.2.7.7 **Measurement and payment**

The pay items in this Clause shall include full compensation for all work associated with the demolition and removal of concrete structural elements including initial preparation of concrete surfaces or portions thereof which are not already covered by the measurement and payment items on the Standard Specifications or the Project Specification, such as procurement, transport, access and temporary works, plant and equipment required to undertake the work as specified. General access, work platforms and associated temporary works are covered in Part A.

The quantities indicated in the Schedule of Quantities are based on the dimensions shown on the drawings and on inspections carried out as part of the preliminary and details design phases increased to allow for unforeseen work. It must, however, be accepted that the quantities or work actually done may vary significantly from the scheduled quantities, and that the Contractor shall be deemed to have allowed in his tendered rate for such variations in quantities which can be reasonably expected.

1.2.7.7.1 **Demolition of Concrete Members**

Item	Unit
(Cluster 3: Wattles, India, Dallas, Katlehong, and Lindela)	cubic metre (m^3)

The unit of measurement is the cubic metre of concrete demolished, measured in its original position and shape based on:

1.2.7.7.1.1 Full demolition

1.2.7.7.1.2 Partial demolition

The tendered rate shall include full compensation for all labour, material, screening of the structure for safety and environmental protective measures, equipment and plant as well as for all work and incidentals required to complete the work as specified and required to demolish the concrete member and to load, transport and dump the concrete segments and rubble at the nearest approved dumping site.

	Item	**Unit**
1.2.7.7.2	Removal of Metal Sections Embedded in Concrete:	Each (Ea.)

The unit of measurement shall be the number of metal sections removed. The tendered rate shall include full compensation for all labour, materials, equipment, screening of the structure and protective measures, required for the removal of the metal sections as described on the drawings and disposal of all rubble at an approved waste disposal site and the cleaning of the pocket.

	Item	**Unit**
1.2.7.7.3	Dowels for Joining Old and New Concrete:	Kilogram (Kg)

The unit of measurement shall be the number of 16mm diameter galvanised steel dowels 800mm long including 150mm grouted into existing abutment. The tendered rate shall include full compensation for supplying all materials, all cutting, drilling, grouting, and galvanising and any other operation or thing necessary for the proper execution of the work.

1.2.8 Carbon fibre Reinforcement

1.2.8.1 **Scope of work**

To provide secondary transverse reinforcement to the soffit of the main span of a reinforced concrete bridge deck.

1.2.8.2 **Materials**

Concrete Fibre Reinforced Polymer (CFRP) Laminate or similar approved shall be used. All materials shall be stored, mixed and used strictly in accordance with manufacturer's instruction.

1.2.8.3 **Surface preparation**

All surfaces must be dry, clean, sound and properly cured. Remove all loose materials mechanically by grinding or by water or grit blasting. The surface to be coated must be level, with steps and formwork not greater than 0.5mm. Blow holes and other small surface irregularities should be filled with Epoxy Adhesive. The surface profile shall not deviate in levels by more than 10mm over any 2m. Larger repairs should be made with Epoxy Repair Mortar. After cleaning, remove all dust from the surface with an industrial vacuum cleaner.

1.2.8.4 **Mixing Procedure**

1.2.8.4.1 Epoxy Adhesive

Stir both components well in their original containers before use. Add Component B to Component A. Mix with an **electric hand mixer for about 3 minutes** until the two components are evenly blended to a uniform colour. Mix at low speed so that as little air as possible is entrained (500 rpm max). Only mix sufficient material that can be readily used within its pot life.

1.2.8.4.2 **Application**

1.2.8.4.2.1 Apply the well-mixed Epoxy Adhesive carefully to the properly prepared substrate with a trowel or spatula to form a first layer of about 1mm. Place the Epoxy Repair Mortar laminate on a table and clean it with Industrial Cleaner. Apply the Epoxy adhesive with a roof shaped spatula onto the Epoxy Repair Mortar laminate to a thickness of 1 to 2mm.

1.2.8.4.2.2 Within the open time of the adhesive, place the Epoxy Repair Mortar laminate onto the prepared concrete surface. Using a roller, press the laminate into the epoxy material until the adhesive is

forced out on both sides of the laminate. Remove surplus epoxy adhesive. Samples should be made up on site to check the adhesive used in respect of curing rate and final strength. Measure the compressive bending and adhesive strength after curing.

1.2.8.4.2.3 As a final check, test the Epoxy Repair Mortar laminate for hollows by tapping lightly. The top of the laminate can be painted with a coating material such as Epoxy coat or Concrete Repair Elastic.

1.2.8.4.2.4 Collect all spillage with suitable absorbent material.

1.2.8.5 **Limitations**

1.2.8.5.1 Minimum substrate surface tensile strength 1.5 N/mm^2.

1.2.8.5.2 Maximum service temperature is 50°C.

1.2.8.6 **Clean up.**

Clean tools immediately with cleaning agent. Cured material can only be removed mechanically.

1.2.8.7 **Health Precautions**

Exercise care, as with handling any chemical construction product. Apply barrier cream to unprotected skin before using Epoxy Adhesive.

Skin Contact: Wash thoroughly with soap and water.

Eye Contact: Flush immediately with water for 10-15 minutes and contact a physician immediately.

Respiratory Problems: Remove affected person to fresh air immediately and contact a physician.

Hygiene: Wash hands immediately after use. Wash clothing before re-use.

Use adequate ventilation. Use safety goggles and chemical resistant gloves are recommended. Immediately remove contaminated clothing. Dispose of all waste in accordance with local regulations.

1.2.8.8 **Measurement and payment**

The pay item for this clause shall include full compensation for all work associated with the installation of Concrete Fibre Reinforced Polymer (CFRP) Laminate to an existing bridge deck soffit over an existing road, including preparation of concrete surfaces. All costs associated with access and traffic control shall be measured and paid under Temporary access.

1.2.8.8.1 **Carbon Fibre Reinforcement** metre (m)

The unit of measurement shall be the metre of Epoxy Repair Mortar laminate complete in position. The rate tendered shall include full compensation for all surface preparation, materials, plant, equipment, labour and incidentals required to install the Epoxy Repair Mortar Concrete Fibre Reinforced Polymer (CFRP) Laminate complete in position.

1.2.9 Surface and Structural repair of Concrete members

1.2.9.1 **Scope**

This specification covers the requirements for the surface and structural repair of structural concrete members. It covers the requirements for the removal of defective or contaminated concrete and for reinforcement, the preparation of the exposed concrete surface and reinforcement for the rehabilitation of the member, and the repair or replacement of concrete with cementitious mortars, epoxy systems and proprietary concrete repair compounds.

1.2.9.1.1 **Aggregate**

Aggregates shall comply with the requirements of SABS 1083.

1.2.9.2 **Interpretation**

1.2.9.2.1 **Supporting specifications**

The following specifications shall be read with and shall form part of the contract:

1.2.9.2.1.1 Project Specification

1.2.9.2.1.2 SABS Standard Specifications for Road and Bridge Works (1998).

1.2.9.3 **Materials**

1.2.9.3.1 **General**

In addition to compliance with the requirements of the SABS Standard Specifications, materials shall comply with the relevant Clauses of this specification.

1.2.9.3.2 Cementitious mortar or concrete

Materials used in the cementitious mortar or concrete shall comply with the following requirements:

1.2.9.3.2.1 Cement

Cement shall be ordinary CEM.1. (42.5) or CEM.1.(42.5R).

1.2.9.3.2.2 Aggregates

Aggregates shall comply with the requirements of SABS 1083.

1.2.9.3.3 Admixtures

Admixtures shall comply with the requirements of ASTM C-194 or AASHTO M-154 and shall be of an approved brand and type.

1.2.9.3.4 **Epoxy systems**

Epoxy systems shall consist of a solvent-free, two-part adhesive consisting of a resin and hardener curing at ambient temperatures. The hardener shall be polyamide based with a high resistance to moisture. The epoxy shall be supplied and used in accordance with the manufacturer's instructions and recommendations regarding the intended use thereof. Aggregate for epoxy mortars shall be dry when mixed with the epoxy system.

1.2.9.3.5 **Proprietary cementitious repair compounds**

1.2.9.3.5.1 The materials for proprietary cementitious repair compounds shall be supplied as a factory pre-packed dry premix of cements, aggregate and other proprietary products requiring only the addition of pre-packed liquid or a prescribed volume of water of an approved quality to produce the usable repair product. The proprietary repair compound shall compensate for shrinkage in both the plastic and hardened states and shall be suitable for use in the proposed mix and placing techniques.

1.2.9.3.5.2 Proprietary concrete shall be highly workable and self-compacting without the use of vibrators. The aggregate grading shall be designed to prevent segregation during transportation and placing. The concrete system shall have a low alkali content to ensure minimal risk of alkali-silica reaction and shall contain no chlorides. The proprietary concrete shall comply with the material properties as indicated on the detail drawings, alternatively the following shall apply:

Table A: Characteristic compressive strength (Minimum)

AGE (DAYS)	COMPRESSIVE STRENGTH (MPa)
3	30
7	40
28	60

Modulus of Elasticity (Static): 30 GPa < Ec < 35 GPa - BS 1881: Part 121 : 1983 All the necessary health, safety and fire precautions stated by the manufacturer shall be complied with. Only material of which the shelf life has not expired shall be used.

1.2.9.3.6 **Bonding Agents**

Non-cementitious bonding agents shall be either a single-component emulsion based on modified acrylic type resins or a slow-setting, solvent-free epoxy resin supplied as a two-part material, pre-

packaged and ready for on-site mixing and application, and shall be of an approved brand and type suited to the application.

1.2.9.3.7 **Anti-corrosion primer for reinforcement**

The anti-corrosion primer shall be a single component material based on zinc and epoxy resins and shall be of SABS approved type and brand suited to required application.

The primer shall be supplied and used in accordance with the manufacturer's instructions and recommendations regarding the intended application. All necessary health, safety and fire precautions stated by the manufacturer shall be complied with.

1.2.9.4 **Plant and Equipment**

All plant and equipment used for the preparation of concrete surfaces, batching of material and mixing operations shall be in good working order and suited for the intended use. The plant shall be inspected, serviced, and calibrated at regular intervals and tested to ensure proper functioning, all to the satisfaction of the Project Manager or delegated authority.

1.2.9.5 **Construction**

1.2.9.5.1 **Preparation of repair surfaces**

1.2.9.5.1.1 **Preparation of concrete contact surface**

1.2.9.5.1.2 All surface damaged, loose and soft concrete, concrete containing aggressive ions e.g., chloride, as well as all foreign materials such as oil, paint, grease, inter alia shall be removed from the contact surface using pneumatic chisels or other approved mechanical equipment or thermal/hydraulic techniques. The contact surface shall be treated to expose the aggregate by means of chiselling, sand blasting or high-pressure water-jetting or where it can be shown to produce the required aggregate exposure, a hard brush may be used subject to the Project Manager or delegated authority's approval.

1.2.9.5.1.3 The mechanically prepared concrete surface shall be cleaned of dust by means of oil-free compressed air or water-jetting. The area to be repaired shall be bounded by straight line edges cut to the required depth using a diamond cutting saw, angle grinder or other approved equipment. The edges shall be recessed such that the patch has a thickness at the edge of at least twice the maximum aggregate size of the patching material, but in any case, not less than 10 mm.

1.2.9.5.1.4 **Preparation and protection of embedded reinforcement**

1.2.9.5.1.5 All visible or embedded reinforcement bars showing signs of corrosion shall be exposed by cutting back the concrete around the bar with pneumatic chisels or other approved method. The

corrosion shall be removed by sand blasting, or where this is not warranted, by wire-brushing with power tools to an acceptable surface.

1.2.9.5.1.6 The treated steel surface shall be clean of all corrosion and foreign material likely to impair the bond of the anti-corrosion primer to the reinforcement.

1.2.9.5.1.7 No chemical solvents shall be used without the approval of the Project Manager or delegated authority.

1.2.9.5.1.8 Reinforcement that has experienced significant pitting or reduction in diameter shall be referred to the Project Manager or delegated authority for acceptance.

1.2.9.5.1.9 All rejected reinforcement shall be cut out and replaced with new bars of the same type and size, allowing for a minimum overlap of 45mm diameter with the in-situ bars.

1.2.9.5.1.10 All exposed and cleaned reinforcement shall receive one coat of a single component anti-corrosion primer based on zinc and epoxy resins, which shall be evenly applied to achieve a minimum 40-micron millimetre kiln dry film thickness.

1.2.9.5.1.11 The primer shall contain at least 30 % zinc solids by volume. The primed surface shall not be exposed to the atmosphere longer than necessary before the application of the repair mortar, but at least until the coating is fully dry.

1.2.9.5.1.12 Alternative proprietary anti-corrosion coatings shall be subject to the approval of the Project Manager or delegated authority, based on submitted test documentation and proven performance within the industry.

1.2.9.5.1.13 In cases where the final concrete cover is deemed by the Project Manager or delegated authority to be inadequate the following protection shall be applied at the Project Manager's instruction:

- Cover 0 – 5 mm.

The reinforcement shall receive two coats of anti-corrosion zinc-based epoxy primer as described previously. In order to improve the bond to the covering epoxy mortar, kiln-dry quarzitic sand shall be applied onto the final wet coat.

- Cover > 5 mm

The outer surface mortar patch shall receive a surface coating based on an approved low viscosity cementitious or polymer-based barrier liquid. Where an epoxy mortar is used as repair material, the reinforcement shall be coated as for the 0-5 mm case.

1.2.9.5.2 **Bonding Layer**

1.2.9.5.2.1 **Cementitious mortar or concrete repair**

Concrete surfaces that exhibit a high moisture absorption shall be wetted prior to patching, the mortar being applied only when the surface has dried sufficiently to have a matt moist appearance, preferably on the dryish side.

1.2.9.5.2.2 The bond of the patching mortar to old concrete may be enhanced by brushing a thick cement paste into the prepared concrete surface before applying the mortar to the fresh paste.

1.2.9.5.2.3 Generally, the cement paste shall consist of one part cement (same type as for patching mortar) and one part sand (< 2 mm) mixed with water to a thick, but fluid consistency.

1.2.9.5.2.4 The use of polymer dispersive additives to improve workability and bond characteristics shall be subject to the approval of the Project Manager or delegated authority.

1.2.9.5.2.5 Alternatively, an approved adhesive or bonding agent may be applied to the prepared surface so as to enhance the bond of the fresh mortar to the dry concrete in accordance with the manufacturer's instructions. Only compatible materials shall be used.

1.2.9.5.2.6 Epoxy mortar repair

The repair surfaces shall be covered with a thin compatible bonding layer of epoxy resin. Should the time interval between resin and mortar application exceed 24 hours, the wet bonding layer shall be sprayed with a kiln-dry quartzitic sand to achieve a sandpaper-like covering. All loose sand shall be brushed off before applying the epoxy mortar to the bonding layer.

1.2.9.5.2.7 **Proprietary cementitious repair compounds**

The contact surfaces shall be prepared and treated with a compatible bonding layer in accordance with the manufacturer's specification.

1.2.9.5.3 **Repair material**

1.2.9.5.3.1 Cementitious mortar or concrete

1.2.9.5.3.1.1 The cementitious repair mortar shall comply with the strength requirements of the concrete in the structural member to be repaired. The water/cement (w/c) ratio shall not exceed 0,5 and guidelines for the composition of mortars and concretes consisting of different aggregate sizes are given in Table A.

1.2.9.5.3.2 The Contractor shall, however, be responsible for the final design of the repair mix and shall submit a test report by an approved testing laboratory to the Project Manager or delegated authority for approval prior to its use in the permanent works.

Table B: Cementitious mortar/concrete composition: guidelines

	Layer thickness (mm)	Materials proportions cement: Aggregate (by mass)	Max aggregate size (mm)	Grading limits for aggregate % passing by mass								
				mm 0,15	mm 0,30	mm 0,60	mm 1,18	mm 2,36	mm 4,75	mm 10,0	mm 12,0	mm 19,0
Mortar	0 -10	1:2,0 to 1:2,5	2	2 to 10	10 to 60	50 to 75	100					
	10- 20	1:2,5 to 1:3,0	5	2 to 10	10 to 30	25 to 60	50 to 80	80 to 100	100			
Concrete	20- 40	1:3,0 to 1:3,5	10	2 to 10	8 to 20	20 to 35	35 to 55	50 to 70	70 to 85	100		
	40- 80	1:3,5 to 1:4,0	16	2 to 10	5 to 17	10 to 30	20 to 40	35 to 55	50 to 70	70 to 90	80 to 95	100

1.2.9.5.3.3 **Epoxy mortar**

The suitability of the epoxy mortar for a particular application shall be proved by testing or submission of an approved industry track record of usage under similar circumstances.

1.2.9.5.3.4 The epoxy mortar shall consist of a waterproofing membrane with a compressive strength equal to or greater than the adjacent concrete and it shall exhibit similar temperature expansion characteristics. The elastic modulus, E., shall not exceed that of the parent concrete. Aggregate (fine and coarse) shall be clean and dry and the size shall not exceed one third of the minimum patch thickness.

1.2.9.5.3.5 Guidelines for the composition of suitable epoxy mortars are shown in Table B. However, the Contractor shall be responsible for the final mix design and shall submit details to the Project Manager or delegated authority for approval prior to its use in the permanent works.

Table C: Epoxy mortar composition: guidelines

	Layer thickness (mm)	Material proportions cement:	Maximum aggregate size (mm)	Temperature Coefficient of Expansion 10^{-6} / ^{o}C

		aggregate (by mass)		
Paste	0 – 5	1:2 – 1:5	0,5	< 30
Mortar	0 – 20 >20	1:8 – 1:10 1:14 – 1:16	2 8	<20 <15

1.2.9.5.3.6 **Proprietary cementitious repair compounds**

The suitability of the repair compound for a particular application shall be proved by testing or submission of an approved industry track record of usage under similar circumstances.

The Contractor shall submit details of the proprietary cementitious compounds to the Project Manager or delegated authority for approval prior to its use in the permanent works.

The repair systems shall be either:

A. Repair System 1

Priming steel surfaces:	Zinc Rich Primer
Priming concrete surfaces:	for Concrete repair mortar use a slurry coat
Concrete repair:	Non shrink grout or under water. repair mortar
Curing repairs:	Concrete curing compound

B. Repair System 2: Alternative as proposed by the Contractor.

The Contractor shall submit details of Repair System 2 to the Project Manager or delegated authority for approval during the tender period.

1.2.9.5.4 **Batching and mixing**

1.2.9.5.4.1 **Cementitious mortar or concrete**

The constituent parts of the mortar or concrete, i.e., the cement, aggregate and water, shall be weigh-batched.

Mixing of mortar shall be done with plant or equipment suited to the amount of mortar to be mixed.

The batched materials shall be mixed continuously for at least five minutes in a mechanical drum or table type mixer, or, for small amounts, with an electric drill with mixing ladle.

1.2.9.5.4.2 **Epoxy mortar**

The epoxy base and activator shall be mixed strictly in accordance with the manufacturer's instructions.

The epoxy and aggregate shall be weigh-batched. The base and activator shall first be mixed thoroughly for at least 180 seconds and until a consistent uniform colour is maintained, whereafter the aggregate shall be added and mixed to a uniform consistency. The manufacturer's instructions shall be strictly adhered to.

1.2.9.5.4.3 **Proprietary cementitious repair compounds**

1.2.9.5.4.4 The repair compound shall be mixed strictly in accordance with the manufacturer's specifications. Unless otherwise specified the product shall be thoroughly mixed in a forced-action mixer of adequate capacity. Alternatively, a suitably sized drum may be used with a slow speed (400/500 rpm) high torque rotary drill fitted with an approved mixing paddle. The contents shall be properly mixed to ensure a smooth, uniform mix.

1.2.9.5.4.5 The mixing capacity and placing capacity of equipment and labour shall be adequate and matched to enable placing operations to be carried out continuously within the recommended placement time of the product, generally within 20 minutes of mixing ensuring a smooth, uniform mix. The mixed product shall be passed through a suitable coarse metal screen prior to placing or pumping to remove any lumps of unmixed product.

1.2.9.5.4.6 Tools and equipment shall be cleaned after each batch and all previously mixed material shall be removed from tools and equipment prior to charging and mixing a new batch of repair compound.

1.2.9.5.5 **Formwork for structural concrete repair**

1.2.9.5.5.1 Compounds shall be treated with a suitable mould release agent. The formwork surfaces shall match the existing surface textures as closely as possible.

1.2.9.5.5.2 The formwork shall be constructed to be leakproof with suitable provision for the drainage of pre-soaking water or access for the application of a surface bonding layer immediately prior to placing the repair concrete.

1.2.9.5.6 **Application of the repair material**

1.2.9.5.6.1 **Cementitious mortar**

1.2.9.5.6.1.1 After the defective concrete surface and the embedded reinforcement have been prepared, the bonding layer shall be worked onto the concrete contact surface followed directly by the freshly mixed repair mortar. The mortar application shall follow the technique of plastering.

1.2.9.5.6.2 The mortar surface shall be trowelled when the mortar exhibits initial set to obtain a uniform plain surface true to line, matching the boundaries of the repair area, and shall then be finished to match the adjacent existing surface finish.

1.2.9.5.6.3 Local areas, where deep recesses have been cut out, or where concrete has been removed around reinforcement bars, shall be built up in thin layers not exceeding 20 mm over several work sessions.

1.2.9.5.6.4 **Concrete**

After the defective concrete surface or member has been prepared, an approved bonding layer shall be worked onto the concrete contact surface followed directly by the freshly mixed concrete. The concrete shall be properly compacted and where possible, vibrators shall be used.

1.2.9.5.6.5 **Epoxy motar**

The epoxy mortar shall be applied in accordance with the manufacturer's recommendation and specification.

Each layer of epoxy mortar shall be trowelled onto the prepared and primed surface in one work session. The rate at which the epoxy mortar can be applied shall determine the batch quantity such that the pot life of the epoxy is not exceeded. Unused mortar for which the pot life has been exceeded shall be discarded.

1.2.9.5.6.6 **Proprietary cementitious repair compound**

The proprietary compound shall be applied in accordance with the manufacturer’s recommendation and specification.

The minimum layer thickness shall be 10 mm with a maximum as specified by the manufacturer, depending on the orientation of the application.

Each layer of repair compound shall be thoroughly worked and compacted into the repair zone ensuring that full contact with the primed contact surface is achieved and no air entrapment occurs. All sagging or slumping material shall be removed and the contact surface cleaned prior to re-application using a reduced layer thickness.

1.2.9.5.7 **Protection and curing**

1.2.9.5.7.1 **Cementitious mortar or concrete**

The finished mortar surface shall be protected from drying out due to wind, direct sunlight or frost. The Contractor shall arrange such protection to the Project Manager’s approval who will assess each case on its merits.

The surfaces shall be cured over a period of at least 7 days by spraying a uniform, full coat of an approved resin-based curing membrane not later than 8 hours after placement of the mortar, but within 20 minutes after stripping the formwork, or by any other approved procedure.

1.2.9.5.7.2 **Epoxy motar**

The mortar shall be protected from rain and frost for at least 24 hours and shall be cured in accordance with the epoxy supplier's recommendations, or as directed by the Project Manager or delegated authority.

1.2.9.5.7.3 **Proprietary cementitious repair compounds**

Immediately after the proprietary compound has been applied or after formwork has been removed, the repaired surfaces shall be thoroughly cured by means of an approved curing compound and procedure suitable to, and compatible with the repair compound.

1.2.9.5.8 **Reinstatement of concrete cover**

1.2.9.5.8.1 **Cementitious mortar**

The mortar shall consist of one part cement and two parts sand (0-2 mm) by mass with a water/cement ratio not exceeding 0,42. Additives approved by the Project Manager or delegated authority may be used to improve workability.

The mortar shall be applied to minimum thickness of 10 mm and the finished surface shall be treated with an approved diffusion resistant coating. Such coating shall be applied in at least two coats of 150 to 250 g/m^2

1.2.9.5.8.2 **Epoxy Mortar**

Epoxy mortars shall not be applied to structural concrete surfaces with temperatures below +8 °C. The concrete and reinforcement shall be prepared as described in this specification and primed with the bonding layer before applying the approved epoxy mortar based on the size and depth of repair.

1.2.9.5.9 **Dowell Bars into Existing Concrete**

1.2.9.5.9.1 **Preparation of contact surfaces for dowels**

Concrete contact surfaces shall be prepared by removing all surface laitance and damaged, loose and soft concrete, concrete containing aggressive ions, e.g. chloride, as well as cleaning the surfaces of all foreign adherents and impregnates such as oil, paint, grease, curing compounds, dirt, intern alia Inter alia. The contact surface shall be treated to expose the sound substrate by means of chiselling, grit blasting or high-pressure water-jetting.

The mechanically prepared surfaces shall be finally cleaned of loose dirt and dust by means of oil-free compressed air, water-jetting or vacuum cleaning, as appropriate.

1.2.9.5.9.2 **Holes and pockets for embedding dowels, anchorages inter alia.**

Pockets that are formed in concrete must be cleaned of all foreign material and prepared as for the contact surfaces in this specification.

Holes shall be drilled using approved mechanical equipment. The size of a drilled hole is dependent on the type of grout to be used, and as a guideline the following sizes shown in Table C below are recommended as a minimum, based on the dowel or anchor bar diameter, B.

Table D:

Grout type	Diameter of hole	Minimum depth of hole	Direction and Inclination
Cementitious Epoxy resin	1,5 to 2,0 D 1,3 to 1,5 D	15.D 15.D	As detailed on drawings

The diameter, depth, direction and inclination of the holes required shall be as shown on the detail drawings but shall not be less than the dimensions scheduled in Table B. Before the holes are grouted, the dowel bars, anchors, inter alia shall be cleaned, and all water, concrete and residue and other foreign material shall be blown out of the hole with compressed air.

1.2.9.5.9.3 **Pre-soaking**

The use of a cementitious compound requires the pre-soaking of the concrete substrate with water several hours prior to grouting. All free water shall however be removed from the surface and holes or pockets immediately prior to grouting.

The use of an epoxy or polyester resin grout usually requires a clean and substantially dry contact surface. No pre-soaking is required unless specified by the grout manufacturer.

1.2.9.5.9.4 **Formwork**

Temporary formwork to place and contain the fluid grout may be required. Reference shall be made to the manufacturer's recommendations regarding flow distance based on the gap width and the fluid head at the pouring side.

The unrestrained or exposed surface area of the grout shall not extend more than 50 mm beyond the perimeter of the smaller contact surface. The formwork shall be constructed to be leakproof to prevent wastage and loss of material.

1.2.9.5.9.5 **Batching and mixing**

1.2.9.5.9.5.1 The proprietary grout shall be batched and mixed strictly in accordance with the manufacturer's instructions and specifications.

1.2.9.5.9.5.2 Unless otherwise specified, the product shall be mixed thoroughly in a forced action mixer of adequate capacity. Alternatively, a suitably sized container equipped with a slow-speed (400/500 rpm), high-torque rotary drill fitted with an approved paddle may be used. The liquid components shall be properly mixed to ensure a smooth uniform mix prior to adding the aggregate.

1.2.9.5.9.5.3 The premixed aggregate shall be added slowly to the liquid binder and mixed until an evenly coated and wet mix is obtained.

1.2.9.5.9.5.4 The mixing and placing capacity of equipment and labour shall be adequate and matched to enable placing operations to be carried out continuously within the recommended pot life or placement time of the product, generally within 15 minutes of mixing for cementitious grouts. The mixed product shall be passed through a suitable coarse metal screen prior to placing or pumping to remove any lumps of unmixed product.

1.2.9.5.9.5.5 The mixed product shall not be used after expiry of the pot life and all material unused after the placement time limit, shall be discarded. All previously mixed material shall be removed from tools and equipment prior to charging and mixing a new batch of grout.

1.2.9.5.9.6 **Placement of grout for bedding or gap filling**

1.2.9.5.9.6.1 The mixed grout shall be placed within the placement life or pot life of the material in accordance with the manufacturer's instructions regarding specific placement, recommendations and procedures.

1.2.9.5.9.6.2 In general, continuous grout flow is essential, hence sufficient mixed grout shall be available prior to commencing placement, and the rate of placing a batch shall be matched to the time taken to batch and mix a new batch.

1.2.9.5.9.6.3 Placement shall take place at one end of a gap to ensure continuous flow through the gap expelling all air from the exit opening. A sufficient grout head shall be maintained at the inlet end to ensure a continuous grout front through the gap.

1.2.9.5.9.6.4 For an epoxy grout a single batch shall not exceed 30 ℓ of mixed material. For large batches of cementitious grout, placing by pump may be considered.

1.2.9.5.9.7 **Grouting of dowel bars and anchors into holes and pockets**

1.2.9.5.9.8 The grout type and consistency used shall be suited to the application and adequate measures shall be taken to prevent grout loss from the hole or pocket during the setting period. If necessary, a thixotropic grout shall be used.

1.2.9.5.9.9 The hole or pocket shall be filled with the prepared grout making allowance for the displacement of material by the item to be embedded. Immediately after the hole has been filled with grout to the determined level, the embedment object shall be inserted slowly into the hole with a rotary motion so as to displace the grout without incurring over-displacement, which may leave the hole not full, and ensuring complete wetting of the object and the concrete faces.

1.2.9.5.9.10 Precautions shall be taken to ensure that the hole is completely filled and no air is entrapped.

1.2.9.5.9.10.1 The embedded object shall not be disturbed until the bond is effective, and the necessary support shall be provided to hold the object firmly in position until the grout has gained sufficient strength.

1.2.9.5.9.11 **Protection and curing**

The exposed grout surfaces which are not cut back shall be protected from wind, rain and high temperature which can cause rapid drying out in cementitious grouts.

Cementitious grouts shall be thoroughly cured by means of an approved curing compound and procedure suitable for the product.

1.2.9.5.10 **Crack filling**

1.2.9.5.10.1 **Extent and sequence of work**

1.2.9.5.10.2 The extent of the work will be indicated by the Project Manager or delegated authority and no work may commence unless instructed by the Project Manager. The extent of the actual work may vary very significantly from that indicated in the schedule of quantities and the Contractor is advised to discuss the extent of the work with the Project Manager or delegated authority at the outset of the contract before establishing the necessary personnel, equipment or plant on site.

1.2.9.5.10.3 Following the erection of the necessary temporary access and working platforms at the work location, the Project Manager or delegated authority, assisted by the Contractor shall undertake a detailed inspection of the existing concrete surfaces to identify cracks requiring filling. The Project Manager or delegated authority shall then issue an instruction to the Contractor detailing the extent and nature of the work. In general, only cracks exhibiting a surface crack width exceeding 0,2mm shall be filled unless instructed to the contrary.

1.2.9.5.10.4 **Surface preparation**

1.2.9.5.10.4.1 All surfaces within 50mm of a crack line shall be thoroughly cleaned of all foreign material likely to impair the bond of the surface sealant to the concrete by high pressure water jetting, wet grit blasting or other approved mechanical means. All loose spalls and foreign materials within

the crack shall be similarly removed followed by final cleaning with clean, oil free compressed air. The concrete surface and crack shall be allowed to dry out completely and finally cleaned before commencing with crack filling.

1.2.9.5.10.5 **Crack preparation**

Cracks shall be chased/reamed out where confirmed by the Project Manager or delegated authority using angle grinders fitted with carborundum disc(s). The finished chase shall be between 6 and 10mm wide by the same depth. The finished chase shall be thoroughly cleaned to remove all loose material and dust.

1.2.9.5.10.6 **Crack filling**

Fill the finished chase with specified material and grind smooth with the surrounding surface when cured.

Crack filling materials:

A. Professional Polyurethane or similar approved.

B. Polymer Modified Surfacing Mortar

1.2.9.5.11 **Crack sealing**

1.2.9.5.11.1 Prepare surfaces as per specification.

1.2.9.5.11.2 Gravity fill cracks with Epoxy bonding or similar approved product in accordance with the manufacturer's instructions.

Or

1.2.9.5.11.3 Apply Epoxy bonding or similar approved product by either roller or brush to fill the cracks as directed by the Project Manager or delegated authority.

1.2.9.5.12 **Partial removal of concrete to expose reinforcement.**

Where a structural element contains embedded reinforcement which will be re-used in the rehabilitation process, the concrete shall be carefully chipped away without damaging the reinforcing bars. Damaged bars shall be replaced with new reinforcement of similar type and size, subject to the Project Manager's approval.

1.2.9.5.13 **Sounding survey**

1.2.9.5.13.1 On instruction from the Project Manager or delegated authority a sounding survey shall be carried out by striking the concrete with a club hammer of approximately 1kg mass and recording the location of hollow sounding areas.

1.2.9.5.13.2 On plane areas of concrete the surface shall be sounded at approximately 300mm centres in each direction. On columns, beams or other similar members with faces less than 300mm wide, each face shall be sounded near each edge or corner at approximately 300mm centres along the member. Where a hollow sounding area is detected, its extent shall be determined by local sounding and its periphery marked on the surface of the member.

1.2.9.6 **Tolerances**

The Contractor shall apply the patching mortar or concrete and finish the surface to the line and level of the existing concrete and within the tolerances specified on the drawings, or if none is specified, to the tolerances specified in SABS Standard Specification.

1.2.9.7 **Testing**

1.2.9.7.1 **Material**

The Contractor shall ensure that only compatible materials are used as ingredients for the repair mixes.

1.2.9.7.2 The Contractor shall carry out pre-construction compatibility tests on the proposed repair system to ensure that the strength and serviceability requirements of the structural rehabilitation are met. The test results shall be reported to the Project Manager or delegated authority and shall be subject to their approval.

1.2.9.7.3 **Acceptance testing**

1.2.9.7.3.1 The Project Manager or delegated authority will assess cast repair concrete or proprietary cementitious compounds according with the SABS Standard Specifications and the relevant Subclauses and any applicable Project Specifications.

1.2.9.7.3.2 Repair material for surface repair will be assessed for compliance based on the 28- day mean strength test result compared to the specified 28-day compressive strength for each class of repair material.

1.2.9.7.3.3 The criteria for compliance with the strength requirements shall be the mean strength result of three test cubes made from the repair material mix used, which are then prepared and tested in accordance with SABS 863 and other relevant standards, by a SABS accredited laboratory.

1.2.9.7.3.4 Test cubes shall be stored and cured in a manner appropriate to the materials to be tested in accordance with the manufacturer's instructions and shall be properly identified.

1.2.9.7.3.5 The strength results shall represent the section of work executed in the period as agreed to by the Contractor and the Project Manager or delegated authority in advance of sampling.

1.2.9.7.3.6 The work at risk due to non-compliance shall be that executed during the agreed period represented by the strength results that failed to achieve the specified strength.

1.2.9.7.3.7 As a consequence of non-compliance in terms of the acceptance criteria, the Contractor shall take such remedial action as the Project Manager or delegated authority may consider necessary. Such action may include removal and replacement of material in repairs at risk and / or further testing. All such costs shall be borne by the Contractor.

1.2.9.7.4 **Testing for durability parameters**

1.2.9.7.4.1 Sampling of concrete / proprietary cementitious repair compounds

1.2.9.7.4.2 A set of four 68 mm +2 mm diameter cores, and a minimum of 80 mm in length, will be drilled from each location from selected concrete / repair compounds elements at an age of at least 28 days.

1.2.9.7.4.3 Additional cores will need to be extracted when chloride conductivity tests are also required. The Project Manager or delegated authority will decide upon the position and frequency of tests dependent upon the sensitivity of the elements to durability consideration and the total quantity of concrete / repair compounds in the project.

1.2.9.7.4.4 All holes left by coring operations will be patched to the satisfaction of the Project Manager or delegated authority.

1.2.9.7.5 **Laboratory Testing**

OPI tests will be carried out on 4 discs cut from cores extracted from cubes made and cured in accordance with SABS 861-3. On completion of the OPI tests, water sorptivity tests will be carried out. Additional slices will be needed if chloride conductivity tests are required. All preparation of samples and testing shall be carried out in accordance with the latest edition of the publication by the Department of Civil Engineering, University of Cape Town, entitled “Manual of Standard Test Methods for Durability Index Testing of Concrete”.

1.2.9.7.5.1 **Tests to be undertaken.**

Testing shown in “Table F — “Durability Tests” shall be undertaken on core samples taken from the structure and delivered to the testing laboratory.

Table E – **Durability tests**

Test	**Comment**
1. Oxygen Permeability Test	Test all cores drilled
2. Water Sorptivity Test	Test all cores drilled
3. Chloride Conductivity Test	On additional cores when required

1.2.9.7.5.2 **Acceptance of concrete / repair compounds on durability criteria**

1.2.9.7.5.2.1 Assessment of OPI results

Results of this test shall be assessed according to the average index obtained from discs cut from the end of the core adjacent to the outer surface of the concrete / repair compounds. Results obtained from the second, inner disc, shall be taken as being the potential index and will be used to assess the quality of the concrete / repair compounds delivered. The difference in the two values is an indication of the effectiveness of the curing.

1.2.9.7.5.2.2 Assessment of water sorptivity results

Results from this test will be assessed in the same manner as the OPI test.

1.2.9.7.5.2.3 Acceptance criteria

Table F – Acceptance criteria for durability

Acceptance Category	**OPI**	**Sorptivity**	**Chloride Conductivity**	
	Log scale	**mm / √ h**	**a)**	**b)**
Concrete / repair compound made, cured and tested in the laboratory	9.8	6.0	0.5	1.0
Full acceptance of in-situ concrete / repair compound	>9.25	<8.0	<0.75	<1.25
Conditional acceptance of in-situ concrete / repair compound	>9.0 < 9.25	<10.0 > 8.0	<1.0 > 0.75	< 1.5 > 1.25
Acceptance with remedial measures of in-situ concrete / repair compound	>8.75 < 9.0	< 12.5 > 10.0	> 1.0 < 1.5	> 1.5 < 2.0
Rejection	< 8.75	> 12.5	> 1.5	> 2.0

1.2.9.7.5.2.4 Clarification of acceptance categories

The descriptions given in the “Acceptance Categories” column of Table D shall be taken to have the following meanings.

1.2.9.7.5.2.5 Full acceptance

Concrete / repair compound will be accepted unconditionally, and full payment will be made.

1.2.9.7.5.2.6 Conditional acceptance

Concrete / repair compound will be accepted with a warning that construction methods should be examined to improve the durability. The Contractor shall carry out remedial work to improve the durability of the concrete to the criterion described as “Full acceptance”, to the satisfaction of the Project Manager or delegated authority.

1.2.9.8 **Measurement and Payment**

1.2.9.8.1 The payment items in this clause shall include full compensation for all work associated with the repair of concrete structures which are not already covered by the measurement and payment items of the SABS Standard Specifications or the Project Specification, such as procurement, transport, additional access and temporary works, plant and equipment required to undertake the work as specified. General access and work platforms and associated temporary works are covered in Part A.

1.2.9.8.2 The quantities indicated in the Schedule of Quantities are based on inspections carried out as part of the preliminary and detail design phases increased to allow for defects that are not visible. The actual work done may vary significantly from the scheduled quantities and the Contractor shall be deemed to have allowed in his tendered rates for such variations as can be reasonably expected.

1.2.9.8.3 New reinforcement will be measured separately.

1.2.9.8.4 **Cementitious mortar or concrete**

(Class) to (Description) Litre (ℓ)

The unit of measurement is the litre of mortar or concrete, of specified class, used for the repair of specified concrete defects.

The tendered rate shall include full compensation for all labour, materials, equipment and plant as well as for all work and incidentals required to break out, prepare. Prime all surfaces, repair and cure the designated areas (including for wastage) all in accordance with the project specification and the repair material manufacturer’s procedures, methods and specifications.

1.2.9.8.5 **Epoxy mortar**

The unit of measurement is the litre of epoxy mortar, of specified type used for the repair of specified concrete defects.

The tendered rate shall include full compensation for all labour, materials, equipment, and plant as well as for all work and incidentals required to break out, prepare, prime all surfaces, repair

and cure the designated areas (including wastage) all in accordance with the project specifications and the repair material manufacturer's procedures, methods and specifications.

1.2.9.8.6 Proprietary cementitious repair compound Litre (ℓ)
(Repair systems) to (description)
The unit of measurement is the litre of proprietary repair compound used for the repair of specified concrete defects.
The tendered rate shall include full compensation for all labour, materials, equipment, and plant as well as for all work and incidentals required to break out, prepare, prime all surfaces and repair the designated areas (including for wastage) all in accordance with the project specifications and the repair material to manufacturer's procedures, methods and specifications.

1.2.9.8.7 **Curing of repaired surfaces**

1.2.9.8.7.1 By coating the surface with
(Type indicated) to (description) square metre (m^2)

1.2.9.8.7.2 Curing by (method indicated) to (description) square metre (m^2)
The unit of measurement is the square metre of concrete repair surface treated or coated by the method and curing compound indicated and accepted by the Project Manager or delegated authority.
The tendered rates shall include full compensation for all labour, materials, plant, equipment and safety measures required to cure the repair work to the satisfaction of the Project Manager or delegated authority.

1.2.9.8.8 **Sounding survey square metre (m^2)**
The unit of measurement for the sounding survey shall be the square metre of area tested.
The tendered rate shall include full compensation for everything that is necessary to carry out the survey as specified or instructed, mark out repair limits on the concrete surfaces and accompany the Project Manager or delegated authority during subsequent inspection to confirm the extent of concrete that is to be repaired on the basis of the sounding survey.

1.2.9.8.9 **Grouting of dowel bars and anchors into:**

1.2.9.8.9.1 holes (hole, diameter and depth stated) Each (Ea.)

1.2.9.8.9.2 pockets (pocket size and depth stated) Each (Ea.)
The unit of measurement shall be the number of dowel bars or anchors installed into holes or pockets as specified.
The tendered rate shall include full compensation for all labour, material, plant and equipment as well as for all work and incidentals required to install each item as detailed on the drawings

including all drilling and cleaning of holes, preparation of pockets, supplying, placing and curing of grout and the installation, support and treatment of each item as indicated.

1.2.9.8.10 **Crack filling** metre (m)

(Repair system to location)

The unit of measurement shall be the metre (m).

The tendered rate shall include full compensation for all labour, materials, equipment and plant as well as for all work and incidentals required to, prepare, prime all surfaces, repair and cure the designated cracks (including for wastage) all in accordance with the project specification and the repair material to manufacturer's procedures, methods and specifications.

1.2.9.8.11 **Crack sealing** Litre (ℓ)

The unit of measurement shall be the Litre (ℓ).

The tendered rate shall include full compensation for all labour, materials, plant and equipment as well as all work and incidentals required to seal cracks with the specified materials in accordance with the material to manufacturer's specifications including for all wastage.

1.2.9.8.12 **Shoring of Excavation Adjacent to Railway Tracks**

The Contractor shall, in compliance with the requirements of SPK7/2, Part A Clause 9.2, appoint a suitably qualified Engineer to design, specify, detail and check all shoring that is required to support the sides of excavations adjacent to railway tracks. The shoring shall be designed to accommodate lateral and vertical loading arising from the following:

1.2.9.8.12.1 Soil

1.2.9.8.12.2 Groundwater

1.2.9.8.12.3 Surcharge from ballast and trackwork

1.2.9.8.12.4 Surcharge from railway traffic

Provision shall be made in the design for drainage of all excavations.

1.2.9.8.12.5 The Contractor shall submit the shoring design and details to the Project Manager or delegated authority for approval three weeks before excavations are programmed to commence.

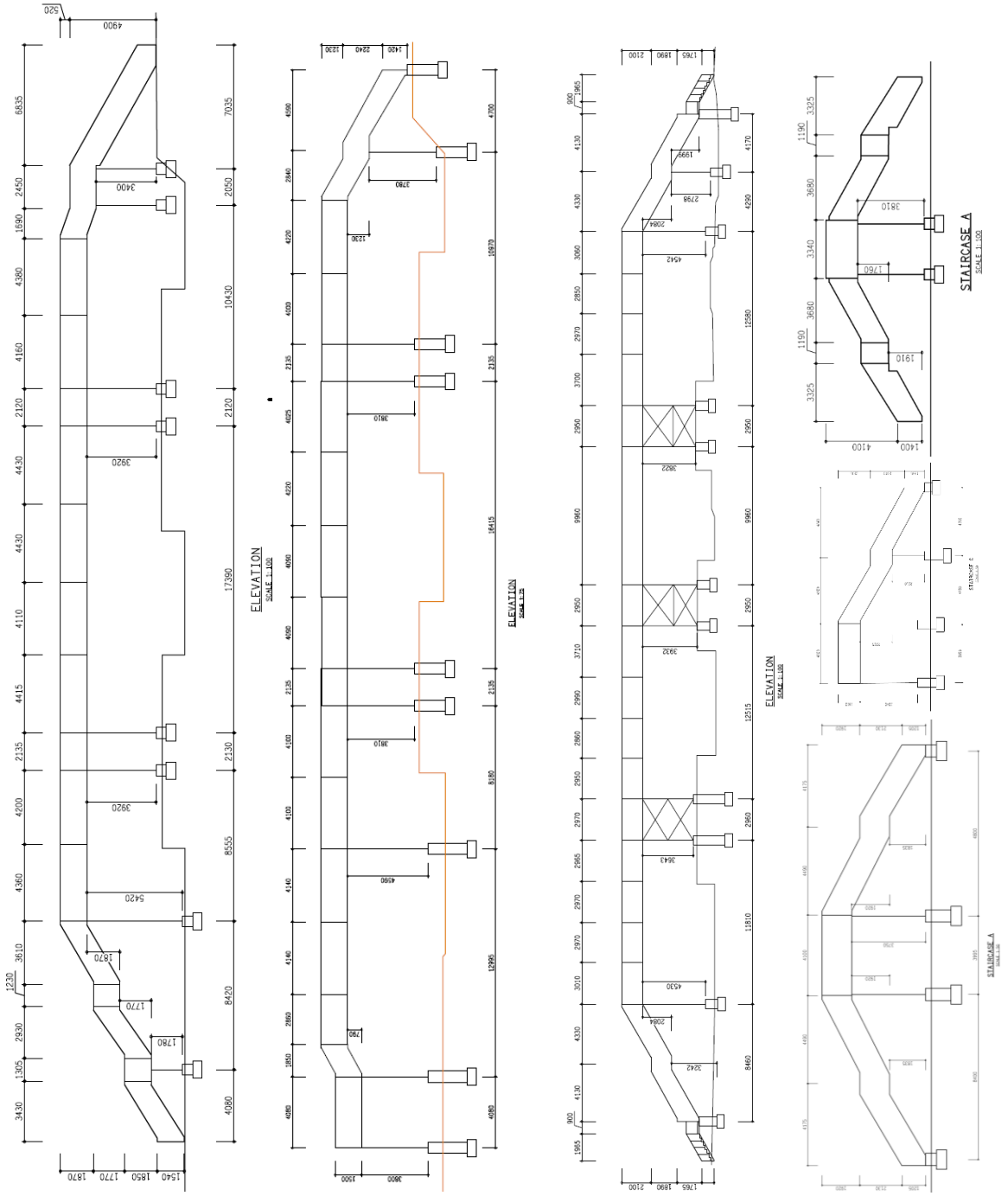
1.2.9.8.12.6 Approval of the Contractor's design and construction details will not release the Contractor or the Professional Engineer, who designed the shoring, from their responsibility for the safety and suitability of the shoring system.

1.2.9.8.12.7 No excavations shall commence until the Engineer has issued written approval for the shoring design and construction system.

PART C: SCHEDULE OF DRAWINGS

1.3 PART C: SCHEDULE OF DRAWINGS

- The drawings of the existing structure
- Photographs of structure


ELEVATION
SCALE 1:100
ELEVATION
SCALE 1:25
ELEVATION
SCALE 1:100
STAIRCASE A
SCALE 1:100

2 TECHNICAL SPECIFICATIONS RELATED TO THE PROJECT

2.1 The documents forming the contract are to be taken as complimentary to each other. In case of any discrepancy or inconsistency between contract documents, the order of precedence will be:

Project Specification	This technical specification
SANS 3000-1 to 2,	Railway Safety Management
SABS 1200NB	Railway Sidings (Track work)
E4E	Safety Arrangements and Procedural Compliance with the Occupational Health and Safety Act (Act 85 of 1993) and Applicable Regulations; including any subsequent amendments;
SABS 1083:1994	Aggregates from natural sources
SABS 0100-2: 1992	The Structural use of concrete – Part 2: Materials and execution of work
SABS 50197 – 1: 2000	Cement – composition, specifications, and conformity criteria. Part 1: Common cements
SABS 1491 – 1: 1989	Cement extenders – Part 1 Ground granulated blast furnace slag
SABS 1491 – 2: 1989	Cement extenders – Part 2 Fly ash
SABS 1491 – 3: 1989	Cement extenders – Part 3 Condensed Silica Fume
Bridge Code: 1983	South African Transport Service
COLTO	Standard specifications for Road and Bridge Works for State Road Authorities, 1998
SANS 1200A	Standardised Specifications for Civil Engineering Construction, Section A: General
SANS 1200C	Standardised Specifications for Civil Engineering Construction, Section C: Site Clearance
SANS 1200D	Standardised Specifications for Civil Engineering Construction, Section D: Earthworks
SANS 1200L	Standardised Specifications for Civil Engineering Construction, Section L: Medium Pressure Pipelines

SANS 1200LB	Standardised Specifications for Civil Engineering Construction, Section L: Bedding (Pipes)
SANS 1200LD	Standardised Specifications for Civil Engineering Construction, Section L: Sewers
SANS 1200G	Standardised Specifications for Civil Engineering Construction, Section G: Concrete
SANS 1200M	Standardised Specifications for Civil Engineering Construction, Section M: Roads (General)
SANS 1200ME	Standardised Specifications for Civil Engineering Construction, Section ME: Subbase
SANS 1200MFL	Standardised Specifications for Civil Engineering Construction, Section MFL: Base (Light Pavement Surfacing)
SANS 1200MH	Standardised Specifications for Civil Engineering Construction, Section MH: Asphalt Base and Surfacing
EN 13481- Part 1	Performance requirements for fastening systems
EN 13146	Test methods for fastening systems
SABS 1431	Grade 300wa for weldable structural steel
SANRAL	Drainage Manual 6th Edition 2013;
TRH4	Structural design of flexible pavements for interurban and rural roads
TRH14	Guidelines for road construction materials
TRH15	Subsurface drainage for roads
TRH17	Geometric design for rural roads
TMH1	Standard methods of testing road construction materials
TMH7	Code of practice for the design of highway bridges and culverts in South Africa TMH7: 1985
PRASA SPECIFICATIONS	
E10	General Specifications for Railway Track work (1996)
E10/1:	Laying of rails
E10/2:	Laying of sleepers
E10/3:	Ballast cleaning
E10/4:	Ballasting and tamping
E10/5:	Destressing of Rails

E10/6:	Building and Replacement of sets
E10/7:	Field welding of Rail joints
E10/8:	Field welding of skid marks
E10/9:	Slewing and Alignment
E10/10:	Drain cleaning
E10/11:	Survey and setting out of Track Alignment and Referencing
E10/14:	Building of New Lines
SPK 7/2	Specification for Works on, Over, Under or Adjacent to Railway Lines and Near High Voltage Equipment
E160	Maintenance of Railway Track with On-Track Machinery
	PRASA SHE Specification
Track Manual	Manual for Track Maintenance (2000)
S410	Specification for Railway earthworks
BBC4038	Geosynthetics Specification for Railway earthworks construction