APPENDIX P
JOINT REPORT SUSPENDED SLAB REPORT

COVEY
ASSOCIATES PTY LTD
Consulting Engineers

JOINT REPORT ORIGINAL SUSPENDED SLAB

AT

PAVILION 1, 50 MARINE PARADE, REDCLIFFE

BY

COVEY ASSOCIATES AND ACOR CONSULTANTS

FOR

MORETON BAY REGIONAL COUNCIL

PROJECT NO: 223164
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1.0 Introduction

This report provides details of the original suspended reinforced concrete slab and forms an Appendix of the Suttons Pavilion - Main Structural Report No. 27747. Details on the extension slab can be found in report No. 27750 in Appendix S of the *Main Structural Report*.

1.1 Component description

Original Suspended concrete slab.

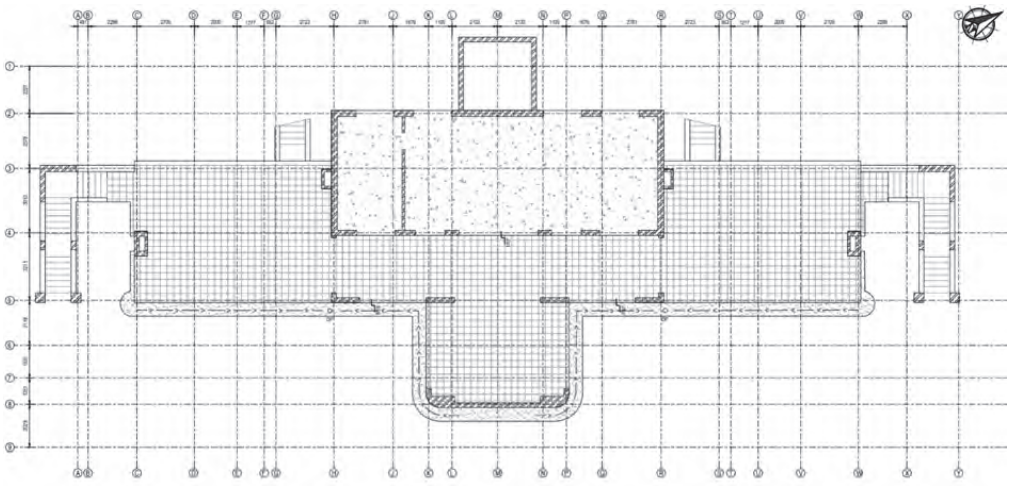


Figure 1: Original suspended slab layout.

1.2 Component reference

There are 2 parts to the suspended slab:

1. Original Figure 1, and;
2. New Extended Suspended Slab circa 2007 additions (see Figure 2).

This section of the report will address the original suspended slab.

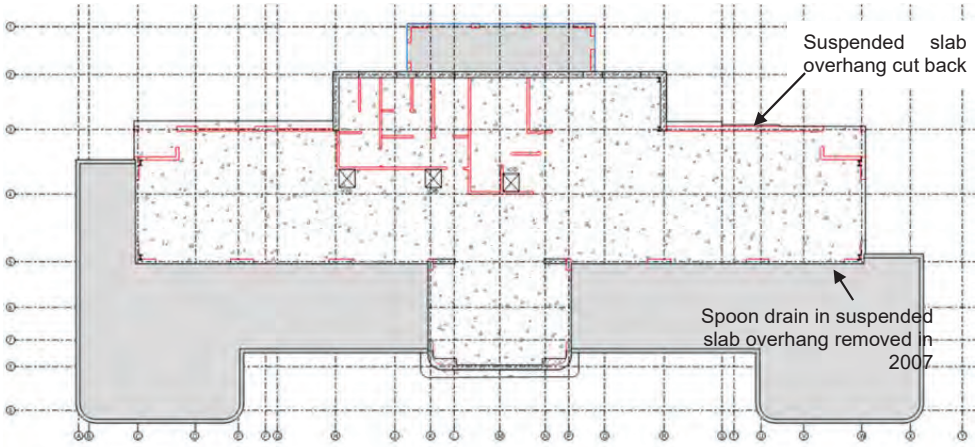


Figure 2: Extension suspended slab shaded built in circa 2007. See Appendix H in Main Report.

1.3 Construction/original use

- The suspended slab sits on top of the rear retaining wall and overhangs on the exposed edges.
- The front overhang was effectively a spoon drain.
- The majority of the upper slab was unroofed terrace. See original floor plan blueprint in Figure 3 below.
- The section between grids 2-4:H-R was originally the internal roofed area or café.
- A section of the veranda between grids 4-5:H-R was also roofed but with no side walls.

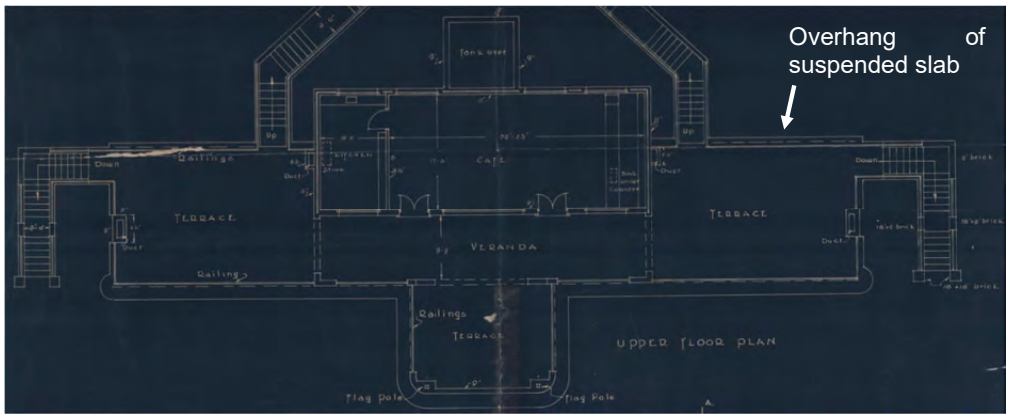


Figure 3: Original floor plan blueprint

Figure 4: Circa 1937. Note the suspended slab overhang and the roofed area.

Figure 5: Shows the tiled veranda with an obvious fall to the spoon drain at the front.

1.4 Structural Components and details

- The original concrete slab was approximately 150mm thick (135mm in the undercroft area – refer Figure 8 below).
- Most of the original slab was covered with a topping of around 5 to 15mm (which may have been an original tile grout or similar). The external slab shown hatched with a square grid in Figure 1 above had another topping slab ranging from 75 to 110mm thick.
- Originally the suspended slab overhung the retaining wall along grid 3 between grids A-H and R-W– it extended past approximately 215 to 250mm past the wall.
- Sections of the overhang have been removed between grids G-H and R-W.
- The suspended slab appears to be continuous pour over grid 3 towards grid 2 between H and R.
- The area of slab between grids 2 and 3 appears to have originally been poured as a slab on ground and later undermined to create an undercroft area throughout. Holes were also made in the undercroft support walls along grids N and L for sewer pipes etc.
- Generally, the soffit of the suspended slab is rendered and painted in most areas, except the undercroft.
- Some original brick walls and concrete lintels were removed. Refer drawing SK101 in Appendix E of *Main Structural Report*, showing brick walls removed.
- The overhang at the rear of the building was cut back to make room for the timber walkway.
- The suspended slab overhang along the sides and most of the front of the building that acted as a spoon drain was cut off to allow for the slab extensions circa 2007.

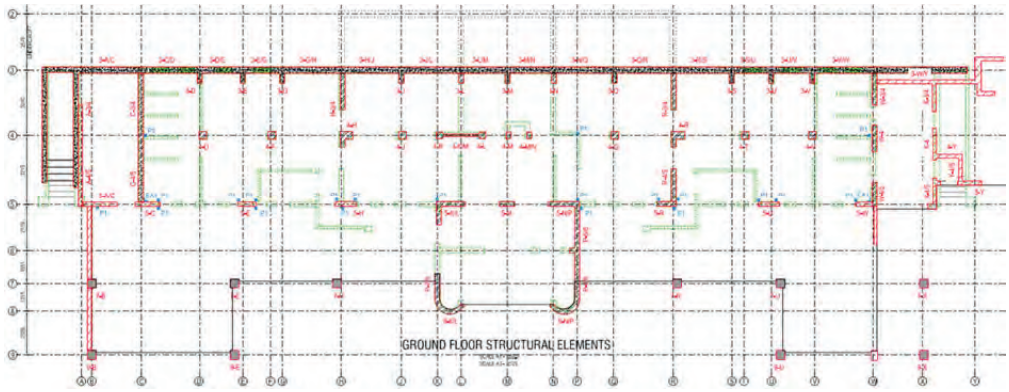


Figure 6: ground floor structural elements. Note that green walls are original brick walls that have been removed.

1.5 Reinforcement

- All reinforcement scanning was carried out by others. See appendix H of Main Structural Report No. 27747.
- Scans by BG&E revealed no reinforcement in the top of the slab.
- Scans found reinforcement in the bottom of the slab to be ¼ inch bars at approximately 100mm centres running in the direction of the lettered gridlines.
- Cover to the bottom reo from the slab soffit was 20-40mm.
- Transverse reinforcement bars running in the direction of the numbered gridlines were scanned by GB&E at ¼ inch bars at 300-400mm.
- Both the cover and spacing of bars was confirmed at breakouts and spalled areas with exposed reo.
- The slab appeared to be a one-way slab in the direction of the lettered grid lines.
- Breakout was carried out to search for steel reinforcement tying the suspended concrete slab to the rear retaining wall. – None was found. Vertical bars exposed during breakouts had hooks finishing within the wall. See Photos in *Rear Retaining wall report* No. 37304.

1.6 Structural Design Parameters

- A suitable live load in accordance with Australian Standards is deemed to be 4kPa. The original slab was exposed to a decent crowd loading in 1953. See photo below.

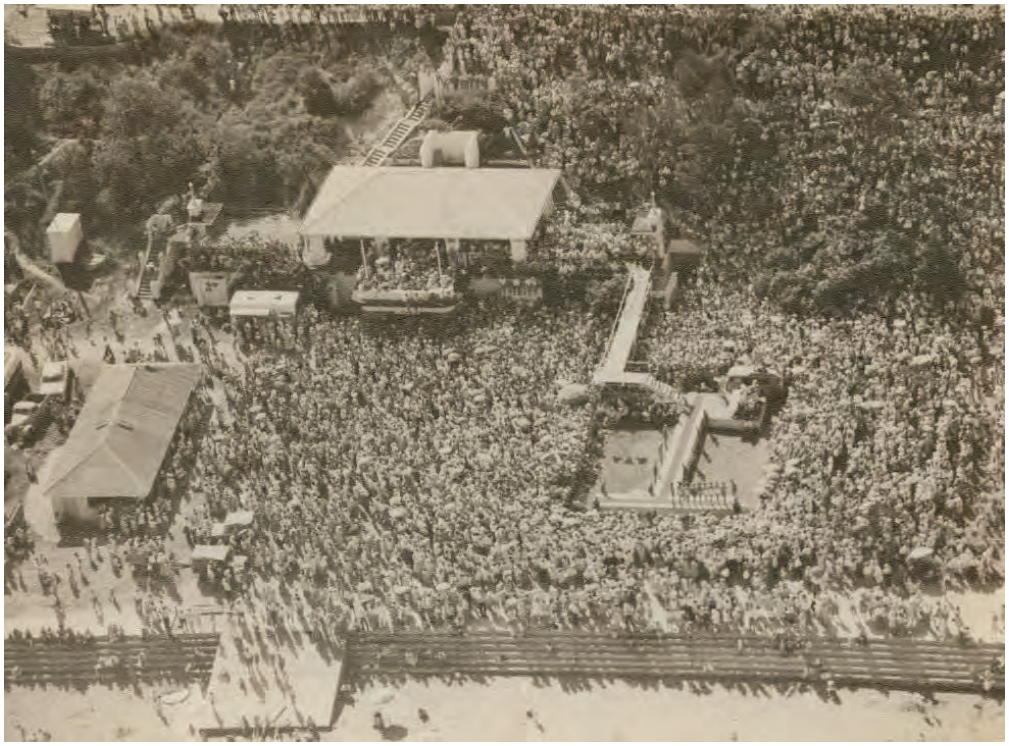


Figure 7: Taken in 1953 showing crowded pavilion.

The original terraced and covered veranda slab areas have been topped with a slab of 75 to 105mm or more thickness. See plan below with hatched area. This equates to an extra 2-2.5kPa dead load on the original slab.

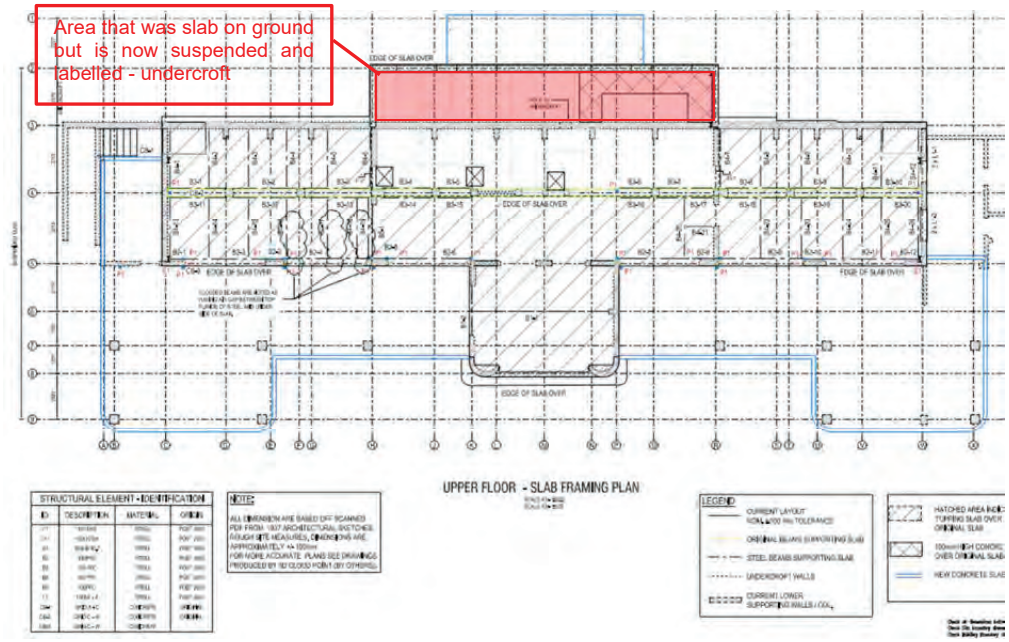


Figure 8: upper floor framing. Note highlighted undercroft area and topping slab hatched.

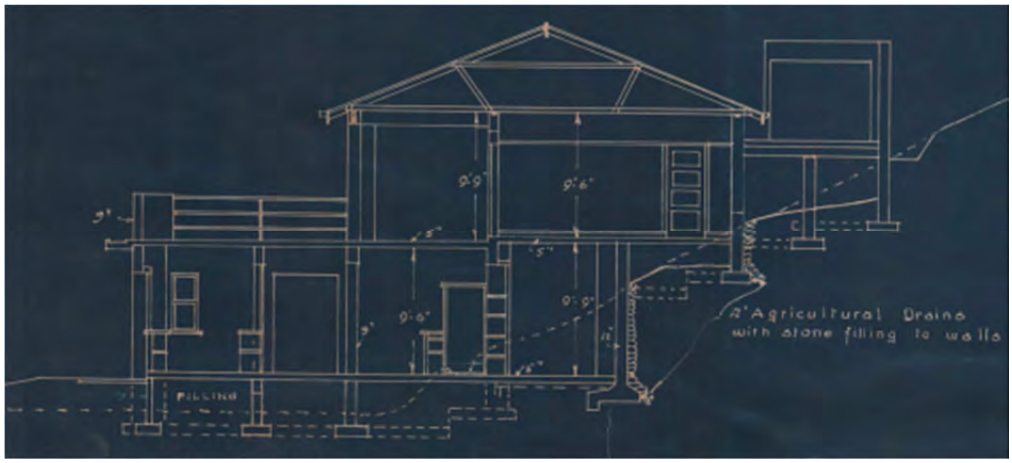


Figure 9: Sketch of slab step section

1.7 History

The history in terms of exposure and demolition is important when assessing the integrity of the suspended slab from strength, serviceability and durability perspectives.

The upper stairs section was originally exposed on both southern and northern stairs. See Figure 10 below. The southern one was enclosed and used as a storeroom circa 2000 and then later refurbished as internal amenities. The northern stair was removed and cut off in 2007 renovations leaving the rear stair wall between grids 3:W-Y. The reo at the cuts was left exposed or hanging out. This remaining northern rear stair wall was and still is retaining and is also part of the "Link Structure".

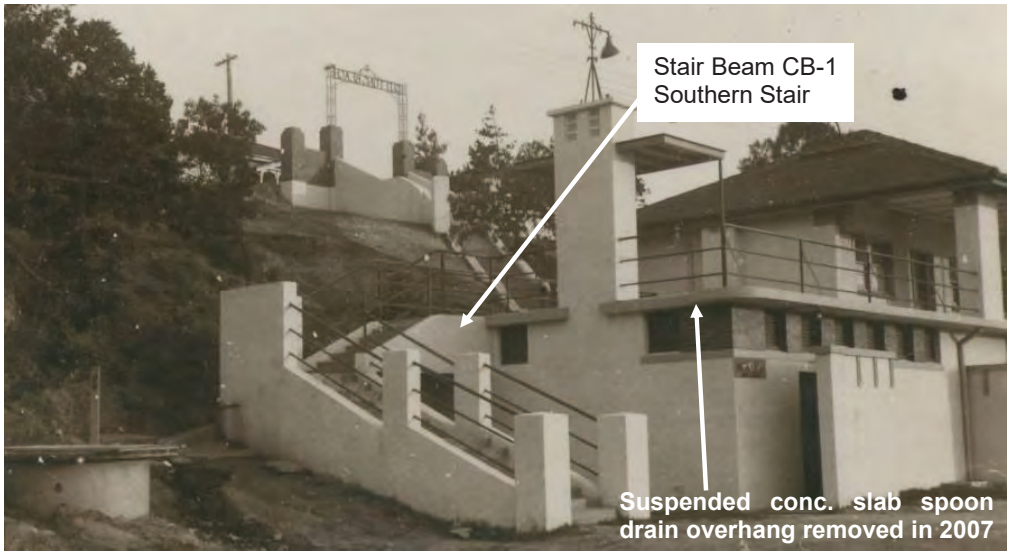


Figure 10: South Eastern end of the building taken circa 1938.

2.0 OBSERVATIONS

Detailed observations, comments with supporting photos taken internally and externally with grid references.

2.1 Section 3-A/C Southern Suspended Stair Soffit

This section covers the southern suspended concrete stairs which were originally exposed for many years before the area was enclosed in for a store room and later for amenities. The Concrete stairs already have concrete delamination on the soffit and the entire area including the platform is currently propped.

The supporting concrete beam CB-1 has spalled, exposed and rusted reinforcement with significant section loss. See Photos.

Photo 1 - Shows suspended stair and landing soffit all propped.

Photo 2 - Shows cracked and delaminating suspended stair slab soffit.

2.2 Section 3-C/D

Externally the overhang is cracked, spalling and delaminating. The render is cracking off and there are holes in concrete substrate. The timber decking and support members are right up against the concrete.

Photo 3 – Externally at joint between slab overhang and timber deck at approximately 3:B-D. Note the timber is against the slab or the small gap is full of debris.

Photo 4 – Suspended slab overhang at southern rear walkway. Note the timber decking has no gap in some areas and/or is full of debris.

Photo 5 – Suspended slab edge at southern end next to timber walkway. Note concrete has spalled and is against timber.

Rear retaining wall section 3-D/C/B

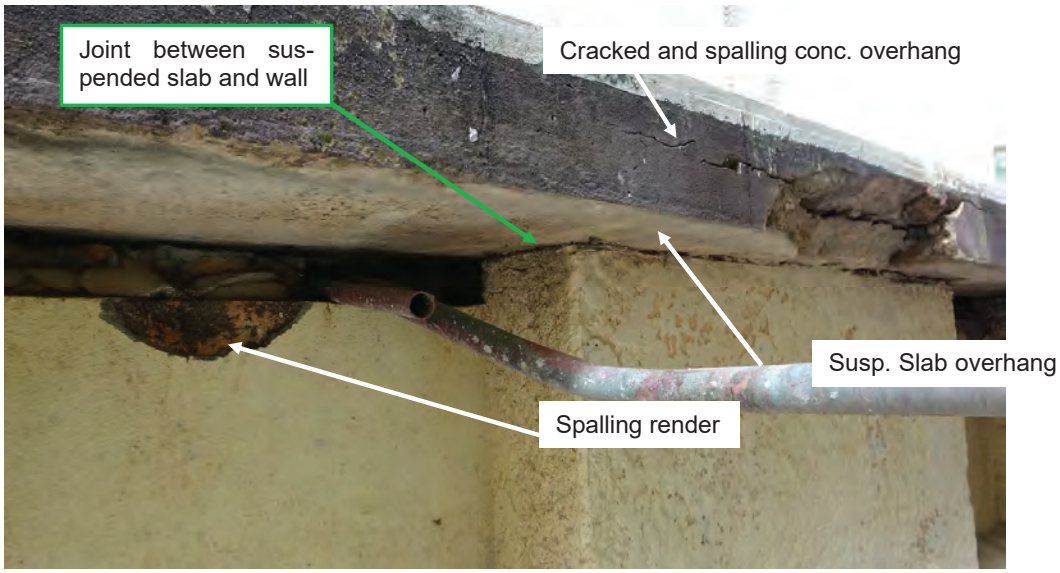


Photo 6 - Rear retaining wall at approx. 3-D. Note gaps above window infills, spalling of concrete overhang, joint between suspended slab and wall.

Photo 7 – Edge of suspended slab overhang cracked on southern end.

Photo 8 - More cracks in overhang edge and notice gap above window infill.

Photo 9 – Cracked soffit of overhang, spalling render and concrete.

Photo 10 – cracking and spalling concrete at edge of overhang of suspended slab.

Photo 11 - Shows the breakouts searching for ties to slab – none were found.

2.3 Section 3-G/H

Externally the edge of the suspended slab overhang is cracked most of the way along this section, with spalling and delamination in some places. The soffit of this overhang also has some of the render missing. See photos.

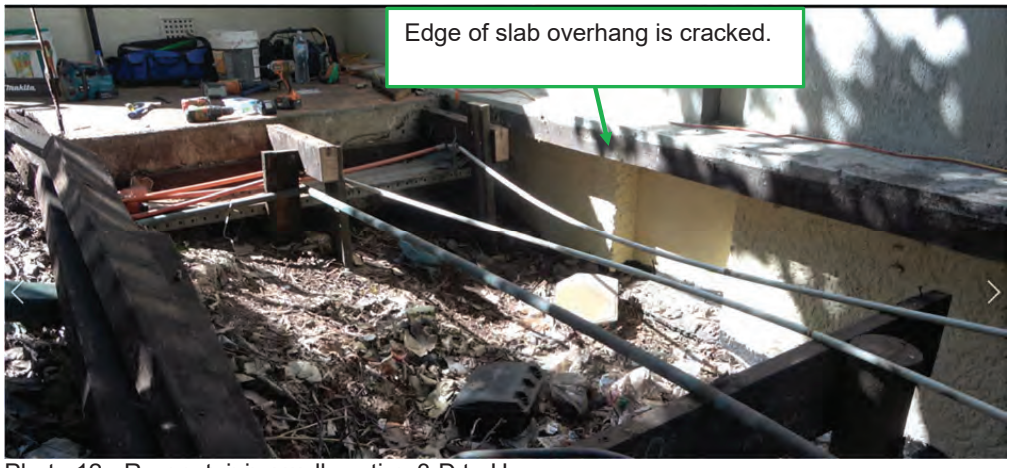


Photo 12 - Rear retaining wall section 3-D to H.

Photo 13 - Excavation behind retaining wall near grid 3:D/G

2.4 Section 3-H/R Slab Over Undercroft

This section of wall supports the continuous slab above which is thought to be originally a slab on ground between grids 2 and 3 and suspended between grids 3 and 4. The slab on ground between grids 2 and 3 was dug out at some point and became a suspended slab.

Note the soffit of the suspended slab is very uneven and rough and has dirt attached to it the same colour as the ground below.

Photo 14 - Rear retaining wall between grids.
Note suspended Slab M and N. Note the hole in the block infill to the undercroft.

Photo 15 - Photo of wall along grid N:2/3 in undercroft.

Photo 16 - Photo looking at corner between grids 2 and N, shows high level footings.

2.5 Section 3-R/W Cut Slab Overhang

This section of the suspended slab at the edge has had the overhang cut off and steel exposed. This was seen once the rear deck was removed. Note live wires tray at back.

Photo 17 - Originally a mirror image to the other end of the building (i.e.similar to 3-A/H)

Photo 18 - Image shows rot in joist, joist adjacent concrete, decking boards above would have been touching the cut concrete slab edge. Note exposed reinforcement rusted and expanding to form a crack in the slab.

Photo 19 - Another view of edge.

Photo 20 - Cut edge of concrete. Exposed reo rusted, delaminating.

Photo 21 – Cut slab edge showing corrosion to reinforcement, expansion of reinforcement caused by delamination, cracking and spalling of concrete.

Photo 22 - View from North to South behind grid 3:W/V showing ground level above vents and timber walkway in direct contact with the ground.

Photo 23 - View of above from other direction.

Photo 24 – View of cut concrete overhang with timber decking against cut section.

Photo 25 - Close up of edge of cut concrete. Note that only the top part above the deck is painted and the timber decking is touching the concrete in most areas or the gap is full of leaf matter and debris.

Photo 26 – start of cut at suspended slab overhang and crack in overhang – see close up below.

Photo 27 – Close up of above crack.

Photo 28 – Top of timber joist along rear deck near 3:U/W

Photo 29 – The underside of the suspended slab overhang along grid 3:T/W has completely delaminated to the depth of reinforcement.

2.6 Section 3-S/T

This section of suspended slab appears to have previous patch repairs to the soffit. It also has the external overhang cut off adjacent the timber decking. There is cracking at the wall to slab join. Also the supporting rear retaining wall has been cut to allow for the vent. It is expected to have similar issues to that mentioned in section 2.7 below.

Photo 30: Rear retaining wall between grids S and T. Note the steel beam is connected to a brick infill section of the wall. Also, the opening for the vent has gaps and is not sealed.

2.7 Section 3-U/V Slab Edge

This section of slab has similar issues to the above-mentioned sections. The slab sofit fell down when the top row of bricks were removed during the strip out, exposing corroded and delaminating bottom steel reinforcement, which was also visible from outside under the timber decking.

The steel slab support beam is also connected directly to the face of the brick infill. The wall is not connected to the suspended slab.

Photo 31: Photo of rear retaining wall between grids U and V. Note the vertical bar on the left cogs over below the slab level. Also note the exposed slab reinforcement due to the slab soffit falling down when the layer of bricks directly beneath it was removed.

2.8 Section 3-V/W

Similar issues to the above sections were found here. Note cracking at slab/wall interface. Some half cell potential tests were carried out in the slab soffit in this area. Corroded reinforcement was found at concrete breakouts along the edges. Testing showed a high potential for corrosion – See BG&E report in Appendix H of *Main Structural Report*.

Photo 32 - Close up of the above vent penetration in rear retaining wall between grids V and W. Note the vertical bar at buttress column corner is hooked and does not extend into the slab.

Photo 35: Area showing reinforcement scans and start of half cell potential investigation at V-W:3-4.

Photo 36 - The slab is supported on a number of steel beams which appear to be in reasonable condition with some surface rust in places and only a few areas of significant corrosion: as shown in this photo at 3:V/W.

2.9 Wall at grid W – cut off stairs exposed.

Photo 34 – Reinforcement bars left hanging out of wall and stair beam where original Northern stairs were cut off at Grid 3:W.

Photo 37 - Slab edge at W-4/5. Note patches, cut concrete, spalled concrete, rendered concrete.

2.10 General issues in slab

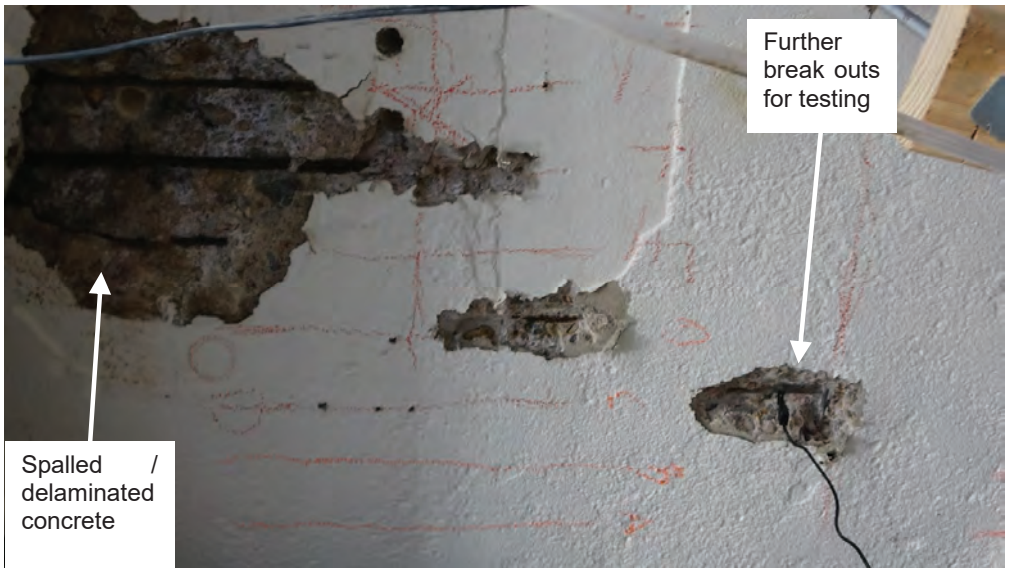


Photo 38 - 20mm diameter core was taken at Grid L:2-3 through the crack. It was very crumbly and fell apart, aggregate was loose and not well compacted. There was a sandy section at the top of the slab core.

Photo 39 – Boney and poorly compacted concrete core sample take at grid L:3/4.

Photo 40 – Close up of above also shows sandy top section.

2.11 Steel floor framing support beams

Generally, the steel framing is in reasonable condition with minor surface rust and pitting. There are a few localised areas where the corrosion is more significant. A number of steel beams are connected directly to the face of brickwork which is unable to support any eccentric load when checked to current standards.

Photo 41 - Rusted steel support beams.

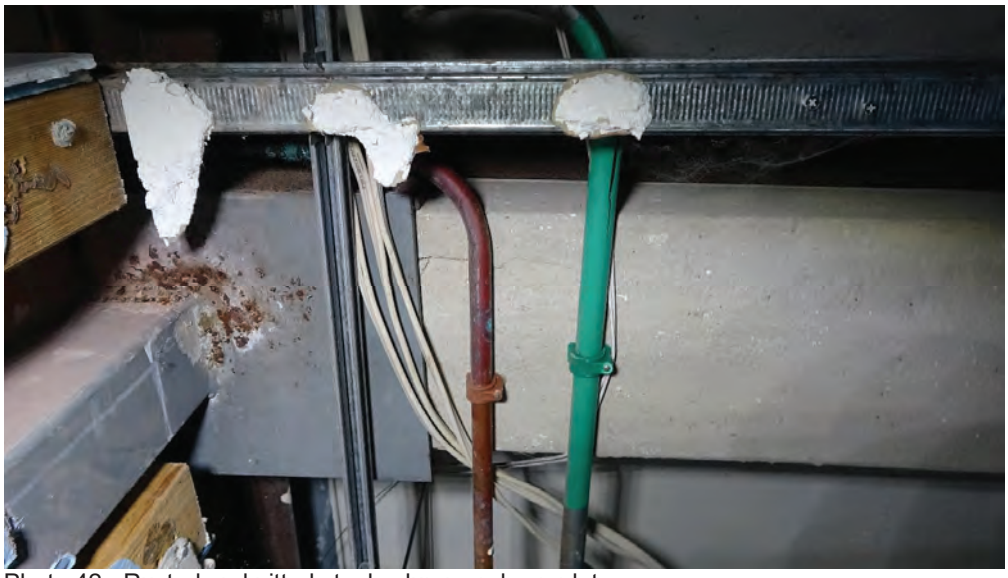


Photo 42 - Rusted and pitted steel column and cap plate.

2.12 New / Extension Slab

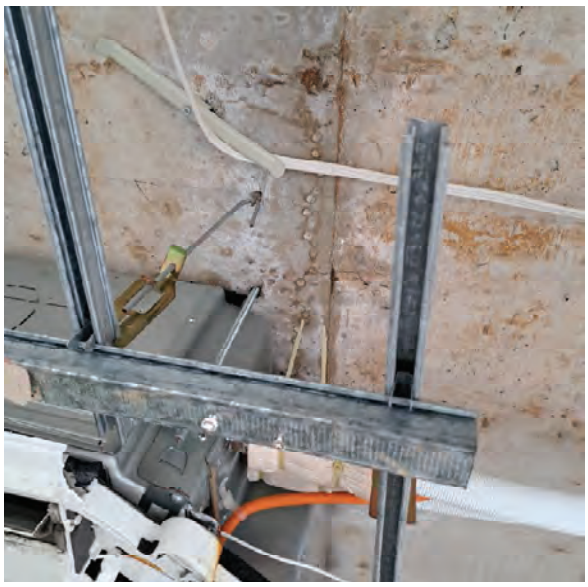


Photo - 43
Cracking with water ingress in new slab

Photo - 44
Close up of water ingress through crack

Photo 45 - Shows water ingress at slab joint old to extension coming down wall.

Photo 46 – Shows water ingress at slab joint old to extension coming down wall.

3.0 DISCUSSION

3.1 General

Generally, the condition of the suspended slab is poor. There are previous repairs, some of which have cracked and even spalled. See summary of issues below.

3.2 Southern suspended stairs and landing

Note this area has been exposed top and bottom for years with the top being exposed its entire working life. The support beam (CB1) is in very poor condition with no residual life and is supported by props so is considered failed. See BG&E report. The stair and landing soffit appeared to have delaminating concrete and was sheeted and propped. This stair supports foot traffic to the ramp and should be rectified as a matter of priority. Propping should only be a temporary measure.

3.3 Summary of issues:

- **Slab topped:**
  Significant extra load of up to 2.5kPa
- **Original support walls removed:**
  All or part of the perpendicular along grids D, L, N, V and W were removed. See Figure 6 above or planSK101 in Appendix E of the *Main Structural Report*. Also note that some walls

were not replaced with alternative supports. Some beams were installed offset from original wall location.

- **Spalling of slab soffit in internal areas**
- **Evidence of previous patch repairs**
  Some of these areas have already delaminated**.**
- **Drummy areas of soffit:**
  See BG&E Report for details.
- **Leaks/water ingress:**
  See report on leaks – waterproofing under tiles could be aged/perished. Water ingress through upper walls etc is occurring as well.
- **Delaminating, spalling and cracked concrete overhangs grid 3: A-H:**
  See photos.
- **Exposed reo at cut overhangs grids 3: R-W:**
  Rear overhangs were cut back and not treated. Timber joist was placed adjacent to the cut concrete with little to no gap. Debris got between the gap. This accelerated reinforcement decay. Hence edge of slab here had delamination of soffit and rusted reo.
- **No connection of wall to suspended slab:**
  There appears to be no connection between the top of the retaining wall and the suspended slab. Vertical bars were exposed at a few locations and they stopped and hooked over within the wall and did not extend across the joint into the suspended slab.
- **Inserts and attachments to slab soffit are conductive with slab:**
  See BG&E Report.
- **Steel beam connection to brick face:**
  Steel beams supporting the suspended slab are connected to the side/face brick window infill in some areas, this is not a suitable connection.
- **Joint between old and new suspended slab leaks in some places.**
- **Other issues are mentioned in the BG & E testing report.**

4.0 STRUCTURAL ANALYSIS

4.1 Suspended stair

No structural analysis on the suspended stair could be carried out as access to the soffit to scan for reinforcement was prohibited by the ply sheeting and props. Depending on the reinforcement layout the stair could span between the rear retaining wall and the concrete beam CB1. However, beam CB1 is propped and needs repair or replacement so this load path is unavailable.

4.2 Structural assessment of Original and new extension suspended slab

See BG&E Report for structural analysis of slab and steel framing support. Appendix K in main report.

4.3 Further structural assessment of the slab

A structural assessment of the suspended slab was undertaken. This included carrying out preliminary structural calculations and slab analysis in both directions to confirm the existing slab capacity assuming no steel corrosion has occurred.

A simply supported two-span beam (1m width slab strip) modelled in the main direction of the slab with the bottom reinforcement of R6-100 spacing along gridline K (first span 3.2m and second span 3.0m). The model assumed that the slab at mid-support (concrete beam along gridline 4) can carry negative bending moment which requires top reinforcement. However, as discussed in the previous section these areas of the slab need to be scanned in order to confirm the existence of any top reinforcement.

The beam has been analysed for ultimate load combination including the self-weight of the slab (150mm structural slab plus 100mm of topping), LL= 4 kPa and additional SDL=1kPa. The ultimate bending moment diagram indicates a positive bending moment of 10.9kNm per m of slab strip and a negative bending moment of 17.9 kN.m per m of the strip.

The ultimate capacity of the slab in the main direction is about 10.1 kN.m. However, the cracking capacity of concrete of the slab is about Mcr=13.5 kN.m. Therefore, the slab in the main direction requires additional strengthening in order to carry the full design loads as required.

A second structural model was undertaken using a simply supported two-span beam (1m width slab strip) modelled in the opposite direction of the slab where the bottom reinforcement is R6-300 to 400mm spacing along gridline 4. The span between steel beams supporting the slab is modelled as 1.85m for both spans. Due to the small span between steel beams, the maximum positive bending moment at midspan of the slab (assuming no negative reinforcement at top of the slab at the mid support) is about 9 kN.m. This is almost 2/3 of the cracking capacity of the slab.

According to AS3600, the minimum reinforcement of the slab should provide a minimum ultimate bending moment capacity of Mu=1.2Mcr. It can be clearly seen that the bottom reinforcement of the slab is not sufficient to comply with AS3600 in order to ensure the concrete slab/beam presents a ductile behaviour.

However, the ultimate bending moment of the slab due to applied loads is less than the Mcr of the slab. Therefore, it is our professional opinion that the concrete slab would not go through a brittle failure between steel beam although it is not complying with AS3600 design requirement. We would then recommend a level of strengthening of the slab, in the secondary direction, of the slab in order to comply with AS3600 ductile behaviour design requirement.

5.0 REMEDIAL OPTIONS

5.1 Southern suspended stair and landing

Remedial requirements for the suspended stair and landing should be similar to, and done in conjunction with, concrete beam CB1 and/or CB2. See report on Concrete Beams for further details in Appendix Q of Main Structural Report.

5.2 Original Suspended Slab

As discussed in the previous section, the existing suspended slab has almost full carbonation depth to the bottom of the slab and there were indications of concrete cracking, concrete spalling and bottom reinforcement corrosion at multiple locations of the slab. The level of the corrosion is extensive, possibly about 60-80%. As it also previously discussed, the level of corrosion due to chloride attack (previous investigation by BG&E) is quite high at locations where the concrete spalling has occurred due to high rate of corrosion of the bottom reinforcement of the slab.

Considering the above-mentioned site investigation findings, the following recommendation and remedial works options are presented, and pros and cons of each option are discussed.

Option-1: Do Nothing

With this option, the slab will continue to degrade, the corrosion of the bottom reinforcement would advance and there would higher risk of slab failure and more concrete spalling of the slab at multiple locations. This option is not recommended due to high level of the risk and also high cost of maintenance and remedial works in future. Also, the slab doesn't meet code requirements and does not have enough strength so it cannot be left as is – something must be done.

Option-2: Floor Slab Replacement
With this option, the entire suspended slab (and most likely the back retaining wall) should be demolished and replaced with new reinforced concrete slab while the other parts of the structure including footings, columns, ground floor slab and the roof frame can be saved. In this option, the construction procedure would be very critical as it involves demolition works whilst parts of the structure are undergoing construction. The construction procedure would involve temporary works whilst carrying out the demolition works, and progressive construction works for the new suspended slab.

Option-3: Remedial Works
With this option, the slab requires remediation works including removal of the carbonated concrete to the soffit of the slab and cleaning of the corroded steel where it is corroded or replacing of the corroded steel with new steel if practical and applying anti-rust coating to the remaining steel, apply bonding agent to the surface of old concrete and finally applying the new concrete to the soffit of the slab (For full details of typical concrete repair specification and procedure of repair works refer to Appendix A).

With regards to removal of the carbonated concrete to the soffit of the slab the following options could be investigated:

1) Hammer and chisel;
2) Use breaker,
3) Sand blasting; or
4) Water blasting.

Considering the size of the slab and amount of the works that would be involved in removing the carbonated concrete, the first 3 options may not be practical or efficient. The water blasting options as proposed by Sika Australia (refer to Appendix B for Sika Method Statement on concrete repairs specification and concrete removal using water blasting) could be considered as an efficient option and can be used in the following areas:

- Water blasting with low pressure (for cleaning)
- Water blasting with high pressure (for roughing); and
- Water blasting with very high pressure (for concrete removal)

Once the carbonated concrete cover is removed and replaced with new repair concrete, an anti-carbonation coating should be applied to the sofit of the slab to protect the slab from further carbonation of concrete. With this option, it is expected to re-instate the defective concrete and restore the slab to almost its original conditions, however the slab is not complying with the AS3600 with regards to minimum reinforcement and the ductile behaviour of the reinforced concrete which then it would lead us to the Option-4 where slab strengthening is required in order to carry the design loads of the building.

Option-4: Strengthening and Remedial Works
This option must be carried out in conjunction with the remedial works to the suspended slab as recommended in the above Option-3. Following the remedial works, strengthening is required to ensure the concrete slab can carry the design loads and comply with the Australian standard for concrete structures AS3600. The strengthening works could include CFRP (Carbon Fibre Reinforced Polymer) strengthening to the soffit of the suspended slab to replace the corroded bottom reinforcement or could include adding steel beams and columns to provide additional supports to

the existing slab. The strengthening works may also be a combination of both CFRP and steel framing to the soffit of the slab. These strengthening options need to be detailed designed in the next stage of the work accordingly to ensure the structure can withstand the full design loads.

Option-5: Cathodic Protection
This option typically is recommended for a reinforced concrete structure that is at the onset of steel corrosion and the durability issue of the structure have not progressed. This option will provide a sacrificial system to the structure that will protect the structure from further corrosion. Thus, the efficiency of this option first needs to be further investigated, the associated cost of installation works and any required remedial works that needs to be carried out should also be assessed. The detailed design of Cathodic Protection method will need to be carried out in next stage if it was considered as one preferred option for remedial works.

6.0 CONCLUSIONS

Suspended slab is in poor condition and requires either remedial and strengthening works or replacement.

It is reasonable to assume that the reinforcement around the perimeter of the suspended slab will need replacing due to:

- the cutting back of original slab overhangs exposing the reinforcement,
- the ingress of water at the join to extension slab exposed the reinforcement to water and corrosion,
- the fact that cracking and spalling of concrete already indicates the reinforcement is corroding and delaminating.

7.0 LIMITATIONS

The proposed remedial works above are only a high-level recommendation and require a full detailed design and further investigation before any construction works can be carried out. Data from others has been relied upon, quoted and used in analyses carried out.

The opinions, conclusions and any recommendations in this report are based on information from, and testing undertaken at or in connection with, specific sample points. Site conditions in other parts of the site may be different to those found at the specific sample points.

The opinions, conclusions and recommendations in this report are based on the assumptions made by Engineers as described in this report. Covey Associates and ACOR Consultants disclaims any liability arising from any of these assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on the conditions encountered and information reviewed at the date of preparation of the report. Covey Associates and ACOR Consultants has no responsibility or obligation to update this report to account for events or changes subsequent to the date the report was prepared.

APPENDIX A
TYPICAL CONCRETE REPAIR SPECIFICATIONS

A.1 Concrete Repair Specification

A.1.1 General

The Contractor shall undertake concrete repairs to the building reinforced concrete slab or other concrete members as per following procedure and specification.

All works shall be in strict accordance with *HB 84:2018 Guide to Concrete Repair and Protection NCC/BCA* (National Construction Code / Building Code of Australia), and relevant Australian Standards.

A.1.2 Scope of Works

The scope of works is repair of all reinforcement corrosion related deterioration to the concrete, including but not limited to:

- Protection to adjacent fixtures and finishes
- Removal and disposal of all existing drummy and delaminated concrete, including any render coatings;
- Break-out of concrete around reinforcement to the requirements of the Specification;
- Treating all exposed reinforcement with a primer system;
- Replacement of severely corroded reinforcement as directed by the Superintendent; and
- Reinstatement of broken-out areas with a cementitious repair mortar.

A.1.3 Inspections

1. HOLD POINT: At completion of the mark-out and repair schedule for submission and approval by the Superintendent.
2. WITNESS POINT: Where the breakout indicates that the surrounding concrete is not sound; or if the reinforcement is corroded at the boundary of the breakout.
3. HOLD POINT: At completion of the break-out and tallying of break-out quantities.
4. HOLD POINT: At completion of cleaning of corroded and exposed steel surfaces to achieve a minimum steel preparation equivalent to AS 1627.4 Class Sa 2½.
5. HOLD POINT: A completion of surface preparation but prior to priming.

A.1.4 Materials

The materials used for the concrete repairs shall comprise the following components:

1. Hand applied repair mortar or poured micro concrete;
2. Zinc-rich reinforcement primer system; and
3. Curing compound (if required).

The repair materials shall be a proprietary system intended for concrete repair. Products equal in performance to the following are considered to be suitable:

- Renderoc HB40 by Fosroc
- Monotop 352NFG by Sika
- Nitoprime Zincrich by Fosroc
- Monotop®-910 N by Sika
- Nitobond HAR

- Concure A99.

Proposed materials shall be provided for approval by the Superintendent at least two weeks prior to proceeding with the works.

A.1.5 Sample Repair

The Contractor shall prepare a sample repair for approval by the Superintendent demonstrating the level of workmanship for each component of the repair.

Sample repairs shall be ready for inspection at least one week prior to proceeding with the associated works. The Superintendent shall be notified in advance of the date when the sample works will be ready for inspection.

The sample repair shall include the procedures required for a typical repair, including:

- Break-out of reinforcement;
- Surface preparation of reinforcement;
- Priming of reinforcement;
- Preparation of concrete surfaces;
- Saw cutting to perimeter of repair areas;
- Priming of surfaces to receive repair mortar;
- Mixing of repair mortar;
- Placement of repair mortar; and
- Inspection of repair after seven days.

The sample repair is to be repeated until the Superintendent is satisfied that the manner of execution meets the required standards and approval is given to proceed.

The approved sample repair shall be referred to as the required standard during execution of the works.

A.1.6 Procedure

The repairs shall be undertaken in accordance with *HB84: Guide to Concrete Repair and Protection.* In addition, the manufacturer's instructions for the specified materials must be strictly followed. If the following specification contradicts the manufacturer's instructions in any way, refer to the Superintendent prior to commencing work.

A.1.6.1 Identification of Areas Requiring Repair

A preliminary survey of the concrete slab has been undertaken to determine the location of existing damage and to estimate provisional quantities of repair. This survey need to be finalized by a final detailed inspection by remedial engineer.

The Contractor shall identify the areas requiring repair by visual and sounding survey.

1. Inspect the concrete surface for signs of corrosion staining, cracking and spalling of concrete.
2. Undertake an acoustic sounding survey of 100% of the concrete surfaces by sounding the surface with a hammer to identify the extent of delaminated concrete at these locations and other locations across the concrete surfaces.
3. The areas requiring repair shall be marked-out on the concrete surface with permanent marker or similar for approval by the Superintendent prior to concrete breakout.
4. Photograph and measure the marked-out area and input into a repair schedule for submission and approval by the Superintendent. **HOLD POINT.**

A.1.6.2 Concrete Breakout

1. Identify location of any embedded services, such as electrical conduits and water pipes, windows, glass and other fixtures that may be affected by the works.
2. Install suitable protection to surrounding areas where breakout of concrete may result in damage of those items. If required, temporarily remove windows or other items that may be impacted by the works.
3. Check the depth of reinforcement prior to saw cutting perimeter of repair areas to ensure the reinforcement will not be damaged by saw cutting. Reinforcement that is damaged by saw cutting shall be replaced at the expense of the Contractor.
4. Provide a border to the repair by saw cutting the marked boundary of the repair areas in a series of straight lines at right angles to the surface to a nominal depth of 10mm.
5. Starting at the marked boundary of the repair, breakout the loose and delaminated concrete using light hand-held percussive equipment or other approved means.
6. The breakout shall be prepared to remove loose or weak concrete, surface laitance and other contaminants. Care shall be taken so as not to damage reinforcement, adjacent sound concrete or fixtures. Take care not to break through the full thickness of the slab or concrete element.
7. Do not extend the size of the repair without approval. Ensure the marked boundary remains visible following breakout.
8. Concrete shall be removed around the full perimeter of the corroded reinforcement for a minimum distance of 25mm measured radially outward from the surface of reinforcement. Ensure there is sufficient space around the bar to allow thorough cleaning of the full perimeter of the reinforcement.
9. Notify the Superintendent where the breakout indicates that the surrounding concrete is not sound; or if the reinforcement is corroded at the boundary of the breakout. **WITNESS POINT.**
10. Subject to approval by the Superintendent, introduce fresh saw cuts 50mm along the reinforcement and breakout the concrete such that the length of breakout along the reinforcement exposes continuous length of 50mm of steel free from active corrosion.
11. Where possible, reposition reinforcement to provide a minimum concrete cover of 30mm. Where this is not possible, seek direction from the Superintendent who may specify alternative repair methods. Any straight bar ends (not cogged) with less than 30mm cover may be cut or ground back to achieve 30mm cover.
12. Notify the Superintendent if any reinforcement has lost over 10% of its diameter due to corrosion or damage. Affected reinforcement shall be replaced in accordance with Clause A.1.6.4 as directed by the Superintendent.
13. Any tie wire, nails, screws, bolts or other metallic components on or near the surface of the concrete shall be removed or the concrete surrounding the metallic component removed and the metallic component cut back a minimum of 10mm.
14. When the full extent of repair has been finalised, ensure that the full perimeter of the repair area has saw cuts installed. Feathered edges to the repairs are not acceptable.
15. The exact size of the breakout shall be photographed and recorded by the Contractor for approval by the Superintendent.
16. The reinstatement work shall not proceed until the breakout has been inspected, the quantities approved by the Superintendent, and approval given to proceed. **HOLD POINT.**
17. The Contractor shall dispose of all material resulting from the demolition process in accordance with Clause **Error! Reference source not found.**.

A.1.6.3 Reinforcement Preparation and Treatment

1. Reinforcement that has lost over 10% of its diameter (as evident once cleaned back adequately for assessment) shall be replaced as directed by the Superintendent.
2. The Contractor shall report to the Superintendent any reinforcement that has been damaged by the work. The Superintendent shall provide further instruction if any additional/replacement reinforcement is required.
3. Corroded and exposed steel surfaces shall be cleaned around the full perimeter of the bar to remove all loose mill scale, corrosion products and concrete to achieve a minimum steel preparation equivalent to AS 1627.4 Class Sa 2½. **HOLD POINT.**
4. The reinforcement shall be thoroughly washed in potable water and allowed to dry prior to application of the reinforcement primer.
5. The prepared and washed reinforcement shall be primed as soon as practicable with the recommended primer to a minimum dry film thickness specified by the product manufacturer and inspected after 24 hours. **HOLD POINT.**
6. If corrosion has reoccurred through the primer coating, the reinforcement preparation shall be repeated to the approval of the Superintendent at the expense of the Contractor.

A.1.6.4 Replacement of Reinforcement

New sections of reinforcement shall be welded on one side with a weld thickness half the new bar diameter. The minimum weld length shall be 10 times the new bar diameter connecting the new bar to a length of existing bar with no visible defects or loss of section. Additional concrete removal may be required to expose a suitable length of bar for welding purposes.

Alternatively, lapping of bars shall be undertaken in accordance with AS3600.

The Contractor shall submit proposed procedures and obtain the approval of the Superintendent before commencing such work.

All reinforcing steel for concrete shall consist of hot rolled plain bar and high yield deformed bar. Plain bar may be used for ligatures and/or to supplement existing plain bar only. Deformed bar shall be used for main reinforcement.

A.1.6.5 Repair Reinstatement

In addition to the manufacturer's instructions, the following shall also generally apply.

1. Determine the volume of repair material required prior to commencing works so as to ensure that the repair material can be properly placed within the recommended timeframes.
2. Pre-wet the breakout so that the concrete reaches a Saturated Surface Dry condition (SSD) immediately prior to the reinstatement of repair material.
3. Mix the proprietary repair material in strict accordance with the manufacturer's instructions, using the correct volume of water and mixing for the required time. Only whole bags of material are to be used. Do not use part-bags. Do not hand-mix the material. Do not add additional water or other additives.
4. Prime the concrete using the manufacturer's recommended primer.
5. Apply the repair material in accordance with the manufacturer's instructions. Pay attention to encasing the reinforcing steel with the repair material. Compact the repair material to ensure no voids or unbonded areas are present.
6. If the repair is deeper than is recommended to be filled by a single application of the repair material, scratch the surface of each layer of material to provide a key for subsequent layers and allow to cure per manufacturer's instructions. Repeat steps 2-7 as required.

7. If the repair is to be applied over a joint in the substrate or incorporates a joint in the surrounding elements, include a corresponding joint in the repair as appropriate and match the original joint dimensions. Use a temporary joint former to achieve a neat edge at the joint.
8. If the repair is to a slab edge, then a drip groove shall be created in the repair as appropriate and match the original drip groove dimensions. The drip groove shall be located to ensure that depth of cover to reinforcing steel exceeds 30mm. Consult the Superintendent for direction where this is not possible.
9. Finish the surface of the repair to match surrounding surface level. Do not apply repair material beyond the repair boundary. Do not overwork the repair surface.

A.1.6.6 Curing of Repairs

Curing shall be provided as soon as practicable after finishing of the repair.

Curing of the repairs is required to prevent excessive drying shrinkage and ensure proper curing of the repair material.

Curing protection shall be provided to repair areas for a minimum of 7 days.

Curing shall be provided by placing heavy-duty polyethylene sheeting in intimate contact with the repair. The sheeting shall overlap the existing concrete to encapsulate the repair area and be securely fastened and sealed to limit air and water ingress.

Alternatively, subject to the approval of the Superintendent, a curing compound may be used for areas where polyethylene is impractical. Curing compounds shall conform to AS 3799 and shall be applied in accordance with the manufacturer's instructions.

Do not overcoat repair surfaces before the repair mortar has cured sufficiently or curing agents have been removed. Confirm with the coating manufacturer the earliest acceptable time when coating can commence and obtain the manufacturer's written advice of this prior to commencement of coating works.

A.1.6.7 Measuring and Reporting

The size, shape, depth, location of each repair together with a photograph shall be recorded by the Contractor in a weekly report.

The volume of repairs shall be measured based on the volume of repair material used. The volume shall be determined based on the number of bags of repair material used for the repairs.

The Contractor shall provide records of the number of bags used and delivery dockets from the material supplier to justify the quantity of product used.

At completion, the Contractor shall provide façade mark-ups and photos showing the areas that have been repaired and overall measurements to justify the quantity of product used.

A.1.6.8 Make Good

The Contractor shall make-good all areas, fittings, fixtures that are affected by the concrete repair works. This may include but not be limited to:

- Sealant repairs;
- Brick masonry repairs;
- Window sealing, etc.

The costs for these works shall be measured and claimed under the Provisional Quantities in the Contract.

A.1.6.9 Defective Works

The following defects in the repairs are not acceptable:

- Cracking around the perimeter of the repair;
- Cracking within the repair;
- Poor compaction or finishing;
- Delaminating or hollow-sounding repairs; and
- Evidence of the use of incorrect procedures.

Defective works shall be completely removed and reinstated at the Contractor's expense.

A.1.7 Pricing

The Contractor shall provide a LUMP SUM for concrete repairs to affected concrete surfaces as per remedial works design drawings. The final cost of the concrete repairs to these areas of the building shall be adjusted if required at the end of project.

APPENDIX B
SIKA METHOD STATEMENT ON CONCRETE REPAIRS SPECIFICATION
AND
CONCRETE REMOVAL USING WATER BLASTING

METHOD STATEMENT
Repairing Concrete Using Sika® Ready to use Mortars

JULY 2014 / V2 / SIKA AUSTRALIA

BUILDING TRUST

TABLE OF CONTENTS

1 SCOPE

This method statement describes the step by step procedure for repairing concrete structures using the Sika® MonoTop®, SikaTop® and Sika® EpoCem® range ready to use mortar products.

2 SYSTEM DESCRIPTION

The Sika® concrete repair range is a system of products consisting of a bonding primer, reinforcement corrosion protection layer; mortar repair and levelling or smoothing mortar.

USES

- Bonding primers for promoting adhesion of a repair mortar on concrete
- Reinforcement corrosion protection applied on steel reinforcement bars in concrete (principle 11, method 11.1)
- Repair and reinstatement of damaged or contaminated concrete on buildings, bridges, infrastructure and super structure works (principle 3, methods 3.1 and 3.3)
- Increasing bearing capacity of a concrete structure by adding mortar for strengthening (Principle 4, method 4.4)
- Preserving or restoring passivity of steel reinforcement bars in concrete (Principle 7, methods 7.1 and 7.2)
- Increasing cover to reinforcement bars with additional mortar
- Thin layer render
- For pore sealing or levelling a concrete surface prior to adding a protective coating
- Repair of minor defects

CHARACTERISTICS/ ADVANTAGES

- Pre-mixed for quality
- 1-component products only add water
- Adjustable consistencies
- Versatile range of performances
- Low shrinkage
- Products with easy surface finishing
- Products with classified performance classes
- Systems with high resistance to water and chloride penetration
- Products which can be hand or machine applied
- Compatible system with Sikagard® concrete protection products

2.1 REFERENCES

This method statement has been written in accordance with the recommendations contained in European Standards EN 1504: Products and systems for the protection and repair of concrete structures, and the following relevant parts:

- EN 1504 Part 1: Definitions, requirements, quality control and evaluation of conformity
- EN 1504 Part 3: Structural and non-structural repair
- EN 1504 Part 7: Reinforcement corrosion protection
- EN 1504 Part 10: Site application of products and systems, and quality control of works

2.2 LIMITATIONS

- Products shall only be applied in accordance with their intended use.
- Local differences in some products may result in some slight performance variations. The most recent and relevant local Product Sheet (PDS) and Material Safety Data Sheet (MSDS) shall apply
- For specific construction / build information refer to the Architects', Engineer's or Specialist's details, drawings, specifications and risk assessments.
- All work shall be carried out as directed by a Supervising Officer or a Qualified Engineer.
- This method statement is only a guide and shall be adapted to suit local products, Standards, legislations or other requirements.

3 PRODUCTS

Sika MonoTop®	1-component, ready to use repair mortar, bonding primer or reinforcement corrosion protection
SikaTop®	3-component, ready to use repair or levelling mortar
Sika® EpoCem®	3-component, ready to use bonding primer, reinforcement corrosion protection or levelling mortar

3.1 SYSTEM BUILD-UP

A Sika® repair system comprises a range of products to suit the needs.

Bonding Primer And Reinforcement Corrosion Protection	
Sika MonoTop®-910 N	Normal use
SikaTop®-110 EpoCem®	Demanding requirements
Concrete Repair Mortars	
Sika MonoTop®-612 N	R4 high strength mortar
Sika MonoTop®-352 NFG/N	R3 normal setting mortar
Sika MonoTop®-412 NFG/N	R4 Normal setting mortar
Sika MonoTop®-436 N	R4 Normal setting form and pour application
Pore Sealer and Levelling Mortar	
Sika MonoTop®-723 N	R3 normal use
Sika MonoTop® FC	Fairing Coat mortar
Sikagard®-720 EpoCem®	R4 demanding requirements

3.2 MATERIAL STORAGE

Materials shall be stored properly in undamaged original sealed packaging, in dry cooled conditions. Refer to specific information contained in the product data sheet regarding minimum and maximum storage temperatures.

4 EQUIPMENT

4.1 MATERIALS

Sufficient quantities Sika® repair materials	Refer to section 11
Sufficient clean water	For mixing 1-component, pre-wetting substrate & cleaning

4.2 ESSENTIAL EQUIPMENT

Hand tools	Trowels, floats, brushes for mortar application
Concrete removal	Traditional tools, hammer-drill or suitable mechanical equipment for removing damaged or contaminated concrete
Measuring cylinder	For accurate measurement of mixing water
Mixing equipment	Refer to section 11.7
Mixing bowl	~18 - 20 litres per 20 kg bag
Sponge or pressurised air (oil free)	Wipe/blow away excess water from substrate
Curing	Membrane or similar to protect fresh mortar
Cleaning	Brush, low pressure water
Waste disposal	For paper bags and excess material

4.3 ADDITIONAL EQUIPMENT

Formwork	To profile application
Sealant	For sealing formwork
Spraying equipment	Mechanical application of mortars
Cleaning Equipment	Suitable for removing corrosion off reinforcement
Suitable profile	For levelling large surfaces

4.4 MIXING EQUIPMENT

Use professional equipment for mixing SikaMonoTop®.

Single mixer with spindle paddle
small quantities

Double mixer with spindle paddles
medium quantities

Forced action pan mixer
large quantities

5 HEALTH AND SAFETY

5.1 RISK ASSESSMENT

The risk to health and safety from falling objects or defects in the structure shall be properly assessed.

Platforms and temporary structures shall provide a stable and safe area to work. Do not take any unnecessary risks!

5.2 PERSONAL PROTECTION

Work Safely!

Handling or processing cement products may generate dust which can cause mechanical irritation to the eyes, skin, nose and throat.

Appropriate eye protection shall be worn at all times while handling and mixing products.

Approved dust masks shall be worn to protect the nose and throat from dust.

Safety shoes, gloves and other appropriate skin protection shall be worn at all times.

Always wash hands with suitable soap after handling products and before food consumption.

FOR DETAILED INFORMATION REFER TO THE MATERIAL SAFETY DATA SHEET

5.3 FIRST AID

Seek immediate medical attention in the event of excessive inhalation, ingestion or eye contact causing irritation. Do not induce vomiting unless directed by medical personnel.

Flush eyes with plenty of clean water occasionally lifting upper and lower eyelids. Remove contact lenses immediately. Continue to rinse eye for 10 minutes and then seek medical attention.

Rinse contaminated skin with plenty of water. Remove contaminated clothing and continue to rinse for 10 minutes and seek medical attention.

FOR DETAILED INFORMATION REFER TO THE MATERIAL SAFETY DATA SHEET

6 ENVIRONMENT

6.1 CLEANING TOOLS / EQUIPMENT

Clean all tools and application equipment with water immediately after use. Hardened material may only be removed mechanically.

6.2 WASTE DISPOSAL

Do not empty surplus material into drains. Avoid runoff onto soil or into waterways, drains or sewers. Dispose unwanted material responsibly through licensed waste disposal contractor in accordance with local legislation and/or regional authority requirements.

FOR DETAILED INFORMATION REFER TO THE MATERIAL SAFETY DATA SHEET

7 SUBSTRATE PREPARATION

7.1 CONCRETE

The concrete substrate shall be thoroughly clean, in a good sound condition and free from dust, loose material, surface contamination and materials which reduce bond. Delaminated, weak, damaged and deteriorated concrete shall be removed by suitable means. If necessary, some sound concrete may also be removed but not to detriment of the structural integrity and only as directed by a Supervising Officer or Qualified Engineer.

Methods of cleaning, roughening and concrete removal are summarised as follows:

■ntended use □ For certain intended uses	Cleaning	Roughening	Removal
Hammer and chisel			■
Breaker		■	■
Grit and sand blasting	■	■	
Water Blasting with low pressure (max. 180 bar)	■		
Water Blasting with high pressure (max. 600 bar)		■	
Water Blasting very high pressure (max.1100 bar)			■

Appropriate tool selection will depend on the type and extent of damage as well as the substrate quality and shall be agreed with the Supervising Officer or qualified Engineer.

Note: Hydro-demolition is a preferred fast and effective method of removing concrete which can result in no micro cracks in the concrete.

As defined in EN 1504-10, water jet categories are as follows:

- Low Pressure – Up to 18 N/mm^2 (MPa) / 180 bar / ~2,600 PSI
  - Used for cleaning concrete and steel substrate
- High Pressure – from 18 to 60 N/mm2 (MPa) / 600 bar / ~8,700 PSI
  - Used for cleaning steel substrate and for removal of concrete
- Very High Pressure –from 60 to 110 N/mm2 (MPa) / 1100 bar / ~16,000 PSI
  - Used for concrete removal when low water volume is available

Where: 1N/mm^2 = 10 bar = 145 PSI (lbf/in^2)

Concrete removal shall be kept to a minimum and shall not reduce the structural integrity of the structure. Pneumatic equipment or tools which can damage concrete due to an intense vibration shall not be used.

The extent of concrete removal shall be in accordance with the chosen principle and method contained in EN 1504-9. In the case of repair and restoration the depth of contamination shall be established and taken into account when determining the depth of concrete removal.

Removal of concrete shall continue to expose full circumference of the steel reinforcement to a minimum depth of 15 mm behind the back of the bars.

Breaking out shall continue along the reinforcement until non-corroded steel is reached as directed by the supervising officer or qualified engineer.

Edges around the patch repair shall be cut at an angle of >90° to avoid undercutting and a maximum angle of 135° to reduce the possibility of de-bonding.

Surface of the concrete substrate shall be roughened to 2 mm to increase bonding which can be tested in accordance with EN 1766: clause 7.2 for horizontal surfaces.

Micro cracked or delaminated concrete including damage caused cleaning, roughening or removal techniques shall be removed or repaired if they might reduce bond or structural integrity. Micro cracks can be detected by wetting the surface and allowing it to dry. Dark lines on the dried surface indicate cracks as they retain the water.

The finished surface shall be visually inspected prior to application and can be tapped lightly using a metal hammer to detect delaminated concrete. The supervising officer or qualified engineer shall be informed immediately of any loose, cracked or damaged surfaces. In these circumstances repair materials shall not be applied without prior written consent of the supervising officer or qualified engineer.

If a smoothing coat is required the whole application surface shall be properly prepared. Appropriate cleaning procedures consist of low pressure water blasting, abrasive grit and sand blasting, or high pressure water blasting to remove a laitance layer.

7.2 STEEL REINFORCEMENT

The steel reinforcement shall be thoroughly clean and free from rust, scale, mortar, concrete, dust and other loose and deleterious material which reduces bond or contributes to corrosion. Tie wire and nails shall also be removed.

The whole circumference of the bar shall be uniformly cleaned, except where structural considerations prevent this. Cleaning shall not damage in anyway the structural integrity of the steel. Immediately notify the supervising officer or qualified engineer if there is a possibility of damaging the steel by cleaning.

Exposed bars contaminated with chloride or other deleterious material shall be cleaned by low pressure water jet (18 MPa) and checked afterwards to ensure the contamination has been totally removed.

If a reinforcement corrosion protection layer in the form of an active coating (method 11.1 as defined in the European Standards EN 1504-9) is to be applied, then the steel reinforcement shall be cleaned to Sa 2 defined by ISO 8501-1.

If reinforcement corrosion protection layer in the form of a barrier coating (method 11.2 of EN 1504-9) is to be applied, then the steel reinforcement shall be prepared to Sa 2½ defined by ISO 8501-1.

Cleaned bars shall be protected against further contamination prior to application of a reinforcement corrosion protection layer.

Loss of steel-area on reinforcement due to corrosion, or due to any other damage, shall immediately be brought to the attention of the supervising officer or qualified engineer prior to any further work. Any further action such as replacing reinforcement bars shall only be carried in accordance with the direct instruction of the supervising officer or qualified engineer. The scope of this method statement does not include replacement of steel reinforcement bars.

7.3 PRE-WETTING SUBSTRATE

Concrete surfaces shall be saturated with clean low pressure water a minimum 2 hours before application ensuring that all pores and pits are adequately wet. The surface shall not be allowed to dry before application.

Just before application, Remove excess water prior to application e.g. using a clean sponge for small areas or air pressure for large areas. Ensure there is no standing water on the surface. The surface shall achieve a dark matt appearance without glistening and surface pores and pits shall not contain water (saturated surface dry). Use pressurised air (oil free) to blow away excess water in difficult to reach areas.

8 MIXING

Mixing shall always be carried out in accordance with the recommendations contained in the latest product data sheet (PDS).

Do not use water beyond the stated maximum and minimum limits.

In determining the mixing ratio the wind strength, humidity, ambient and substrate temperature and shall be taken into consideration.

8.1 ONE COMPONENT PRODUCTS

	Product	Procedure
	**Sika MonoTop®**	■ Place minimum recommended water ratio in mixing container ■ Progressively add powder whilst mechanically mixing using low speed (maximum 500 rpm) electric drill ■ Add more water if required to suit the desired consistency and flow properties but not exceeding maximum dosage. Mix in total for minimum 3 minutes or until the material is homogenous

8.2 THREE COMPONENT PRODUCTS

	Product	Procedure
 	**Sika® EpoCem® and SikaTop®**	■ Shake thoroughly component A and B separately ■ Pour component A into component B and shake thoroughly ■ Pour mixed components A+B into mixing container and add component C progressively whilst mixing mechanically using low speed (maximum 500 rpm) electric drill ■ Mix for minimum 3 minutes until homogenous ■ Do not add water ■ Do not part mix components

9 APPLICATION

The product and system shall be appropriate for the type of substrate, structure and exposure conditions which they are required.

9.1 BEFORE APPLICATION

Working space shall be clean and tidy with no obstructions.

Record the substrate, ambient temperature and relative humidity. Check pot life information on bag or in the product data sheet and allow for climatic conditions e.g. high / low temperatures & humidity.

External applications shall be adequately protected. Do not apply mortar repair in direct sun, windy, humid or rainy conditions or if there is a risk of frost within 24 hours in unprotected areas.

Calculate the required volume for the application and then using the equation in section 10 of this method statement, calculate the yield of the product. Make sure there is enough material on job site to carry out the work.

9.2 REINFORCEMENT CORROSION PROTECTION

Where a reinforcement corrosion protection is required, apply material to the whole circumference of the steel reinforcement bar in two layers. Wait until the first layer has dried before applying the second layer. Use a mirror to inspect behind the back of the bars to ensure full coverage.

Take care not to splash or apply material on a dry concrete substrate behind the bars.

For small areas use two paint brushes to apply 2 layers and ensure full coverage. For larger areas use hopper gun aim the spray in different directions to ensue coverage behind the back of the bars.

The repair mortar shall only be applied when the reinforcement corrosion protection is hardened (wet on dry). Refer to the relevant product data sheet for more information.

9.3 BONDING PRIMER

Refer to relevant repair mortar product data sheet if a bonding primer is required. If a bonding primer is required, the substrate surface shall be pre-wetted in accordance with section 6.3.

Bonding primers can be applied by hand pressing the material firmly into the surface using a brush or using a hopper gun for larger areas.

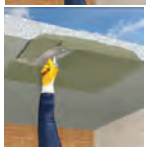
The repair mortar shall be applied wet on wet to a bonding primer. Ensure the substrate surface is fully covered behind the reinforcement bars. For large applications use only a bonding primer with long open time e.g. SikaTop®-110 EpoCem® refer to product data sheet.

9.4 HAND APPLIED REPAIR MORTARS

On a well prepared substrate, the repair mortar shall be pressed firmly in to the repair area. Ensure all the substrate pores and pits are filled.

Check pot life and adjust as necessary the water to powder ratio to suit temperature and application conditions.

When the repair depth exceeds the maximum layer thickness of the repair material, then layers may be built up on top of one another to increase the overall construction depth. The first layer shall be hardened and exothermic reaction of the material completed. The 1st layer shall be at ambient temperature before applying the second layer.



Do not smooth the first layer before applying a second layer. The first layer shall have sufficient roughness to provide a mechanical key for subsequent mortar layers.

Ensure the repair mortar covers the whole circumference of the reinforcement bars and there are no voids left behind the back of the bars.

Finish the surface with a wooden or PVC float. Do not over work the finished surface as this will produce a cement rich surface texture, which may cause the formation of random (crazing) cracking in the surface.

9.5 SPRAY APPLIED REPAIR MORTARS

Repair mortars may be applied using the wet or dry spray technique. Refer to the relevant product data sheet for information relating to spraying. Before using any spray equipment, always read the manufacturers information before starting.

Sprayed mortars are generally applied through a nozzle (Diameter subject to maximum grain size of sprayed material. Refer to machine manufacturer's information) at an angle as close as 90° to the substrate as possible. The application distance between the nozzle and substrate is approximately 200 – 500 mm for the wet spray technique and 600 – 1000 mm away for the dray spray technique.

When spraying ensure the mortar covers the whole circumference of the reinforcement bars leaving no voids behind the back of the bars.

Do not exceed the specified maximum layer thickness of the repair mortar. If necessary, test the spray on an area before starting the main application.

In the case of wet spraying adjust as necessary the water to powder ratio to suit temperature and application conditions.

When the repair depth exceeds the maximum layer thickness of the repair material, then layers may be built up on top of one another to increase the overall construction depth. The first layer shall be hardened and exothermic reaction of the material completed. The 1st layer shall be at ambient temperature before applying the second layer. Do not smooth the first layer before applying a second layer. The first layer shall be cleaned using low pressure water or compressed air before applying subsequent mortar layers.

Finish the surface with a wooden or PVC float. Do not over work the finished surface as this will produce a cement rich surface texture, which may cause the formation of random (crazing) cracking in the surface.

9.6 SMOOTHING / LEVELLING MORTARS

Smoothing mortars can be applied by hand, by hopper gun or by mechanical spray equipment for large areas. Refer to relevant product data sheet for further information.

A smoothing coat shall be applied over the whole prepared concrete surface (including repair and non-repaired areas). Any laitance layer on the surface shall be removed (section 6.1) and surface pre-wet in accordance with section 6.3.

Wait until the repair material has properly hardened before applying a smoothing coat.

Use a toothed trowel to apply the mortar by hand in a vertical direction onto the surface. Hold the trowel at an acute angle to the surface and use different size toothed trowels to regulate the application thickness.

Toothed Trowel Size	Approximate Application Thickness	
	30°	45°
10 mm	~ 5.0 mm	~ 7.0 mm
5 mm	~ 2.5 mm	~ 3.5 mm
2 mm	~ 1.0 mm	~ 1.5 mm

Table 1 Approximate application thickness guide

When 1st layer is hard, apply the second layer between the vertical lines. The hardness can be tested by the ease at which a finger nail can be inserted into the mortar.

Finish surface with damp sponge, wooden or plastic float after material has set. Do not add apply additional water on the surface as this will cause discoloration and cracking.

9.7 CURING

Cure with proper curing methods for 3 days or spray with appropriate curing compound (once any surface water has evaporated) or appropriate curing method. Curing methods include jute and water, plastic sheets or other suitable membranes.

The application shall be protected from wind, rain, frost and direct sunlight. The curing period is dependent on climate conditions. In warm temperatures with low humidity the application shall be protected from premature drying.

9.8 APPLICATION LIMITS

- Avoid application in direct sun and/or strong winds
- Do not add water over the maximum recommended dosage
- Always check the material's pot life and adjust for climate conditions
- Temperature of the repair mortar and substrate shall not differ significantly
- Where the structure is subject to dynamic loading, it is recommended for overhead applications to use repair systems specially tested for this situation

10 INSPECTION, SAMPLING, QUALITY CONTROL

As part of "Good Practice" the contractor shall provide a QC report containing the following recommended data. For more detailed information refer to EN 1504-10 Annex A, or any other local standards or legislation which may apply.

10.1 SUBSTRATE QUALITY CONTROL - BEFORE AND AFTER PREPARATION

The following checks should be carried out before and after preparation.

Characteristic	References	Frequency	Parameters
Cleanliness of Concrete	Visual	After preparation & immediately before application	No contamination, loose particles or defects
Cleanliness of Steel Bars	DIN EN ISO 8501-1	After preparation & immediately before application	No rust, scale or contamination. [Grade Sa 2 or SA 2 ½ for methods 11.1 or 11.2]
Delaminating Concrete	Hammer Sounding	After preparation	No delaminating concrete
Roughness	Visual or EN 1766 on horizontal surfaces	After preparation	Minimum roughness 2 mm (repair area) No laitance layer (smoothing mortars)
Surface Tensile Strength of the Substrate	EN 1542	After preparation works	> 1.0 N/mm² for structural repair

Table 2 QC summary before and after preparation

10.2 BEFORE, DURING AND AFTER APPLICATION

The following checks should be carried out before during and after the application.

Characteristic	References	Frequency	Parameters
Packaging	Visual	Every bag	No damage
Dry product aspect	Visual	2 bags per 10	Loose, no lumps and not compacted
Mixed material	Visual	Every mix	Homogeneous, no lumps no un-mixed dry powder
Precipitation	Record	During application	Keep records and provide protection
Wind Strength	Record	daily	Less than 8 m/sec or provide protection
Batch Number	Visual	All bags	Keep records

Table 3 QC summary before during and after application

10.3 PERFORMANCE TESTING

The following can be used on job site to check the adequacy of the application.

Characteristic	References	Frequency	Parameters
Compressive Strength on 40x40x160 prisms	EN 12190	3 prisms per batch	Within PDS limits
Cracking	Visual	28 days after application	No cracking on application
Presence of Voids/ Delaminating	EN 12504-1 Hammer sounding or *ultrasonic testing	After application	No delaminating concrete
Adhesion Bond *(pull off) (non-laboratory performance)	EN 1542 (Acc EN 1504-10 Table A.2)	Min 3 on a test area	1.2 – 1.5 N/mm² (Structural use) 0.7 N/mm² (non-structural use)

* Optional testing

Table 4 QC summary of performance testing

11 YIELD & CONSUMPTION

The yield of a product can be determined from the following equation (assuming no wastage).

Equation: $\text{yield (litres)} = \frac{\text{(weight of powder (kg) + weight of water (kg))}}{\text{density of mixture (kg/l)}}$

Given: weight of water 1 litre = ~1 kg

Example:

Calculate consumption of a bag weighing 20 kg mixed with 3.6 litres of water, when the density of the fresh material is 2.1 kg/l.

1 bag of 20 kg yields: $\frac{(20 + 3.6)}{2.1}$ = **~ 11.2 litres of mortar**

Therefore, the number of bags required for $1m^3$ of mortar will be:

N° of bags required per $1m^3$ = (1/yield) x 1000

(1/11.2) x 1000 = **~ 89 bags**

Consumption of a product can be calculated as follows:

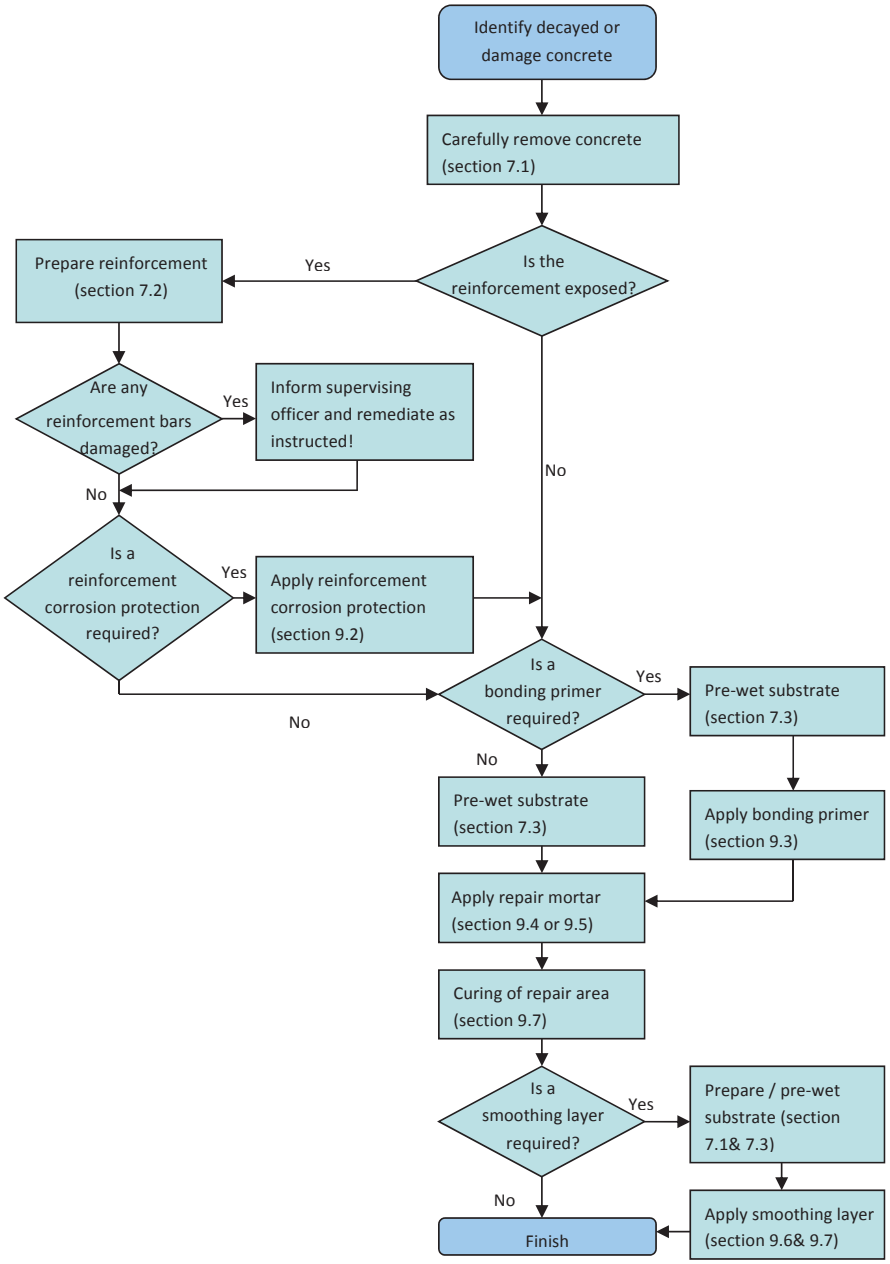
Calculate how many kg of powder is required to cover a 10 mm thick application over an area 1 m^2 (assuming no wastage)

Weight of mixed mortar (kg)	= volume (m^3) x density (kg/m^3)
	= (1 x 0.01) x 2100
	= 21 kg (total)
Less weight of water;	
If water to powder mixing ratio	= *14.5% then;
Required weight of powder	= 21 / ((100+14.5)/100)
	= **~ 18.3 kg powder**

* refer to PDS for exact figure

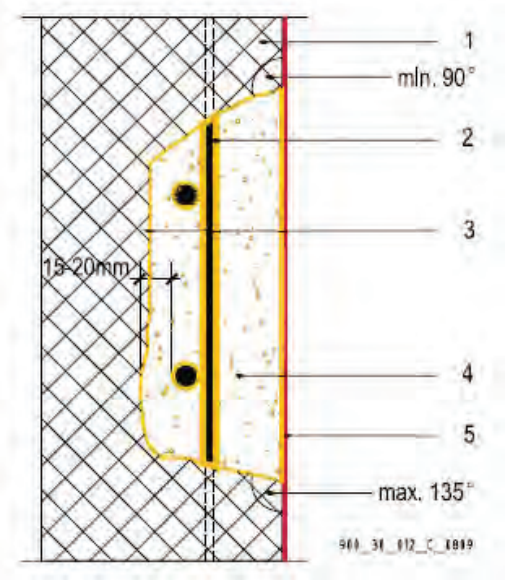
12 CONCRETE REPAIR FLOW CHART

The following is a guide of how to carrying out a concrete repair. This is not intended as a definitive guide to repair concrete and shall at all times be read in conjunction with all Architect's, Engineer's or specialist specifications together with EN 1504-10, local standards and all relevant product data sheets.



13 TYPICAL DRAWING SHOWING SYSTEM BUILD UP

This detail is for illustration purposes only and shall not be used as a construction drawing.

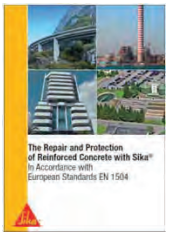


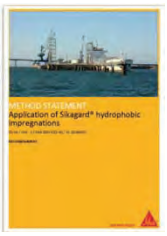
1. Host Concrete structure
2. Reinforcement Corrosion Protection Layer
3. Bonding Primer
4. Repair Mortar
5. Smoothing / Levelling Mortar

14 LEGAL NOTE

The information, and, in particular, the recommendations relating to the application and end-use of Sika products, are given in good faith based on Sika's current knowledge and experience of the products when properly stored, handled and applied under normal conditions in accordance with Sika's recommendations. in practice, the differences in materials, substrates and actual site conditions are such that no warranty in respect of merchantability or of fitness for a particular purpose, nor any liability arising out of any legal relationship whatsoever, can be inferred either from this information, or from any written recommendations, or from any other advice offered. The user of the product must test the products suitability for the intended application and purpose. Sika reserves the right to change the properties of its products. The proprietary rights of third parties must be observed. All orders are accepted subject to our current terms of sale and delivery. Users must always refer to the most recent issue of the local Product Data Sheet for the product concerned, copies of which will be supplied on request.

FOR MORE Repairing Concrete Using Sika Ready to use Mortars INFORMATION:





15 KEY WORDS

Refurbishment, method, statement, process, EN1504, Sika MonoTop, SikaTop, EpoCem, concrete, repair, damage, R4, R3, R2, hand, mechanical, spray, curing, pre-mix, reinforcement, corrosion, patch, smoothing, levelling, pore, sealing

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APPENDIX Q
JOINT REPORT CONCRETE BEAMS REPORT

COVEY
ASSOCIATES PTY LTD
Consulting Engineers

JOINT REPORT ON CONCRETE BEAMS

AT

PAVILION 1, 50 MARINE PARADE, REDCLIFFE

BY

COVEY ASSOCIATES AND ACOR CONSULTANTS

FOR

MORETON BAY REGIONAL COUNCIL

PROJECT NO: 223164
REF: RG/RG/27753RPT – ISSUE A
22 DECEMBER 2022

DOCUMENT ISSUE APPROVAL

Project No:	223164
Title:	Concrete Beam Report
Client:	Moreton Bay Regional Council
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Issue No:	A
Distribution:	Moreton Bay Regional Council – One (1) copy Covey Associates – One (1) copy

CONTENTS

LIST OF APPENDICES

1.0 INTRODUCTION

This report provides details of the original concrete beams supporting the suspended reinforced concrete slab and forms an Appendix of the Suttons Pavilion - Main Structural Report No. 27747.

1.1 Component reference

CB-2 Concrete Beam running along Grid 4 between Grids C and W.

CB-1 Concrete Beam supporting Southern external stair and landing.

Southern external stair and landing will also be addressed in this report.

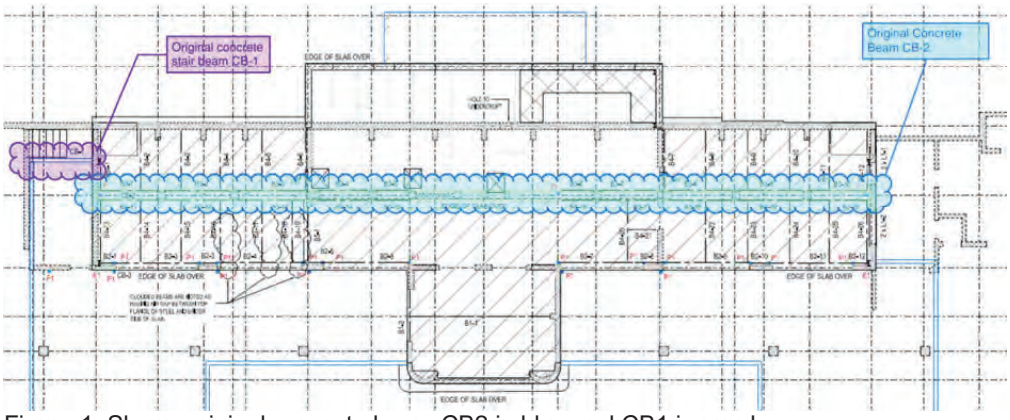


Figure 1: Shows original concrete beam CB2 in blue and CB1 in purple.

1.2 Component Description

Original concrete beam poured integral with the suspended concrete slab in 1937.

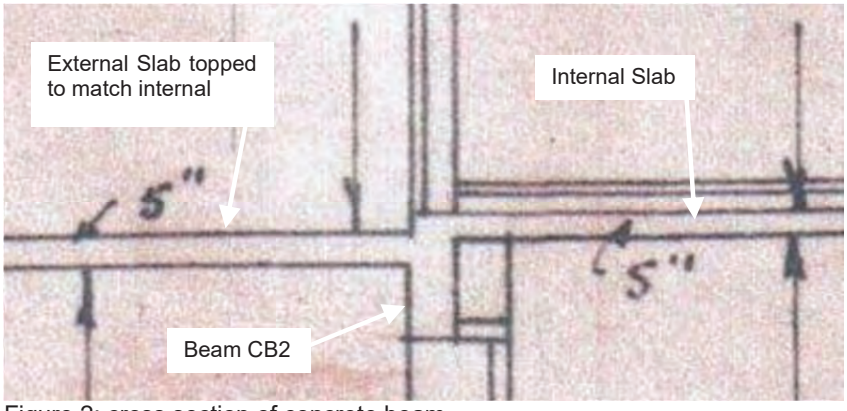


Figure 2: cross section of concrete beam.

1.3 Construction

- Cast in situ concrete.
- Beam varies in depth because between grids C-H, then R-W it was under the original balcony. In the middle between grids H and R the beam was at the step line between internal upper floor and external upper floor balcony. So the top of the beam had a step line in it.

1.4 History

- A load bearing wall support was removed from grid line N and not reinstated. Instead it appears that a steel post was installed on Grid P.
- External slab was a tiled terrace partly covered by a roof only.
- The external slab was not built in until many years later.
- See Slab report for photos and more details.

1.5 Structural Components

- Is approximately 225mm wide.
- Approximately 300-325 deep between grids C-H and R-W.
- At the step line Between grids H and R it is 325 deep on one side and 400 deep on the other, between grids 4-8 and 3-5 respectively.
- The suspended slab design thickness is approximately 150mm thick originally but was later covered with a topping slab that varies from 15mm thick internally to approx. 75-110mm in the diagonally hatched areas in Figures 1 and 4.
- The cast in situ concrete beam is covered with a cementitious render ranging in thickness from 3 to nearly 10mm. This render is also thought to be part of the original construction in 1937 and is found on most other concrete elements on the ground floor including the rear retaining wall, concrete buttress columns and some brick columns and brick walls.
- It is likely that the concrete beam CB2 was clad with a 200 PFC either side during renovations post 2000.
- The PFC's appear to be attached to the existing concrete beam with 1 or 2/M12 bolts at various centres ranging from 400mm at columns to 800-1200 between spans.

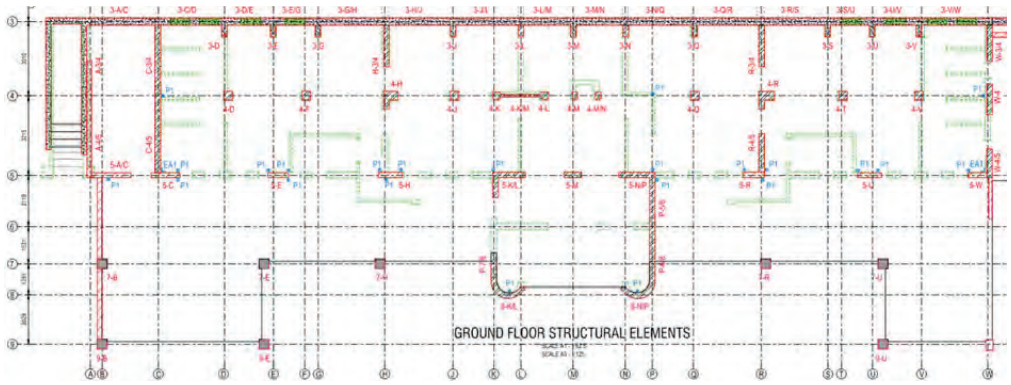


Figure 3: Internal original walls removed shown green, remaining walls black/red.

1.6 Reinforcement

- Scans by others revealed 3 bottom bars of half inch diameter with approximately 20-30mm cover.
- Break outs revealed bottom bars were round half inch diameter with cover ranging from 30 to 40mm at the breakout locations.
- Break outs revealed thinner ligature / hook bars at approximately 15-20mm cover. The size of these bars appeared to be ¼ inch. The spacing of these bars was not determined.

1.7 Other design parameters and assumptions

- 25MPa Concrete.
- Live load of 4kPa.
- No additional / superimposed dead load considered.
- Reinforcement is round bar with 250MPa Yield strength.
- Shear ligs assumed to be at 300 to 400mm spacing. See explanation in observations section.

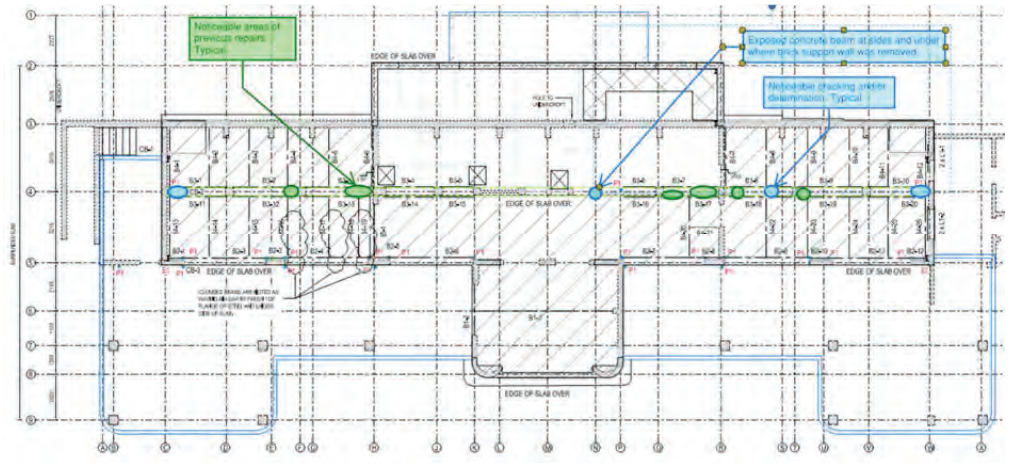


Figure 4: Plan showing existing repair locations and other major defects.

2.0 OBSERVATIONS

A number of photos were taken of the remaining original concrete beams CB1 and CB2. Photo reference locations shown on plan in Appendix A.

P1: Beam CB2 at 4:C/D cracking in render present, minor chips in render.

P2: View of end of CB2 at grid C:4 Note cracks in render and initiation of delamination at side of beam.

P3: Beam CB2 at grid 4:D/E shows side beam with bolts to concrete. Note chips and cracks in render.

P4: Beam CB2 at 4:F/D Note column 4:F on the left hand side. Note previous repair and patch on soffit near column as well as cracks in side face and soffit.

P5: Beam CB2 at 4:F Opposite side of above photo. Note repair patch on soffit and side face.

P6: Beam CB2 at 4:H/F covered with board, has minor cracking.

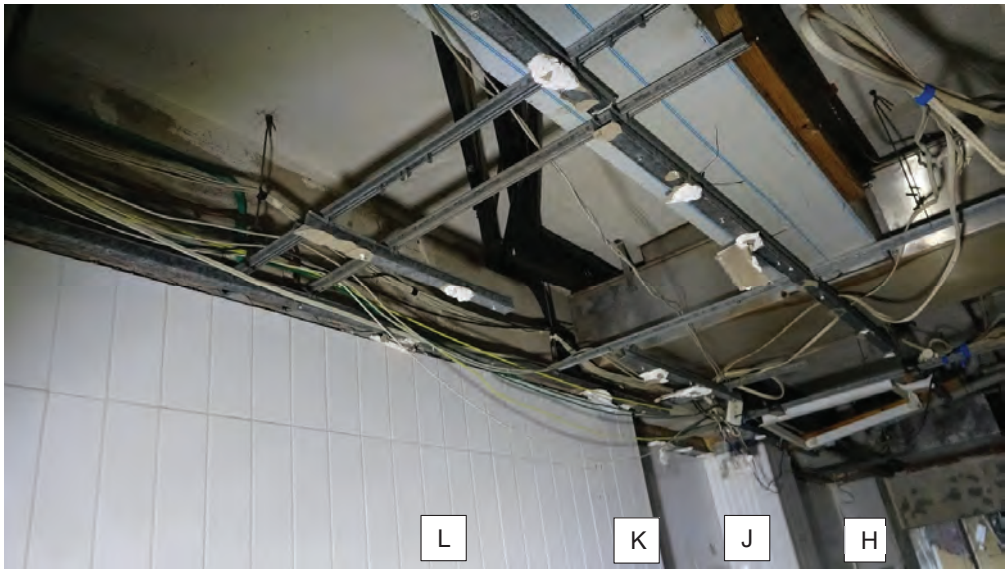
P7: Beam CB2 at 4:H/F Note repairs to both sides and underside of beam near wall at grid H as well as 3 connection points, removed render, discoloration etc.

P8: Beam CB2 at 4:H Opposite side of the above beam. Note repairs on soffit and side face.

P9: Beam CB2 at column 4:H with perpendicular beam/lintel with tiles removed.

P10: Beam CB2 at 4:J/H is painted, note minor defects such as chips and cracks can be seen in the paint up close. Steel side beams are attached to this beam but stop at grid K.

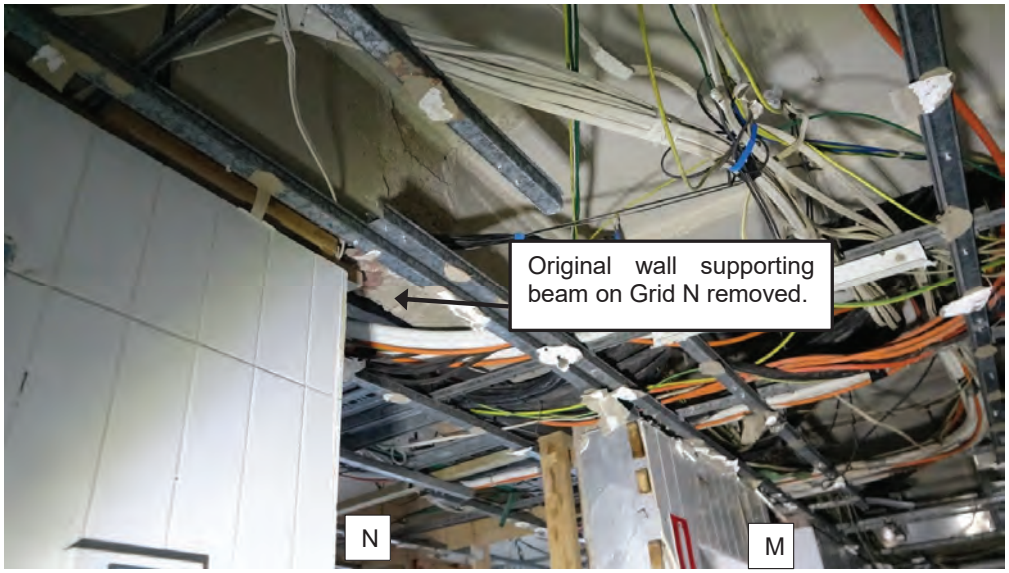
P11: Beam CB2 at 4:K/J is not painted, note minor defects such as chips, cracks in render, various bolt/connection holes and a larger gouge/chip in beam. The steel side beams stop from grid K to P.



P12: Beam CB2 at 4:halfway between grids M and N to grid L. No major defects, only a few chips and cracks in render. Note that there was a wall removed at grid L:3/4 and has not been replaced or substituted with any steel beams or support. There is no render at this location and removal of the wall has taken some of the concrete with it and left less cover in this area.

P13: Beam CB2 along grid 4 from halfway between grid M to half way between L and M. Note the breakout 3 at this location.

P14: Beam CB2 along grid 4 from half way between M and N towards M etc. This beam is not painted and does not have steel side beams. There are no significant defects, only minor chips and cracks in the render.

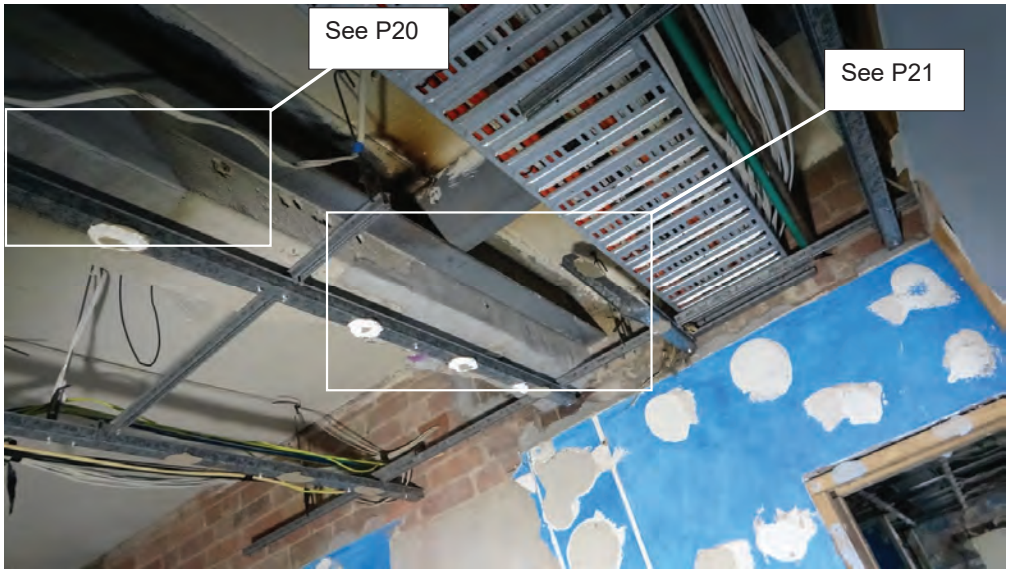


P15: Beam CB2 at 4:P/M Note this beam is not painted and does not have steel side beams. There are some chips and cracks in the render as well as exposed aggregate beam where previous support wall was removed from grid N:3/4. Note that no support under the beam and slab was reinstated at this location.

P16: Beam CB2 soffit at 4:N where previous support wall used to be.

P17: Beam CB2 at 4:Q/P Note damage to beam soffit, holes, missing render, cracks in render etc.

P18: Beam CB2 at 4:Q/P Photo taken from the other side. Note damage to beam soffit, holes, missing render, cracks in render, drill holes in side face etc. The steel PFC side beams start from Grid P to W.



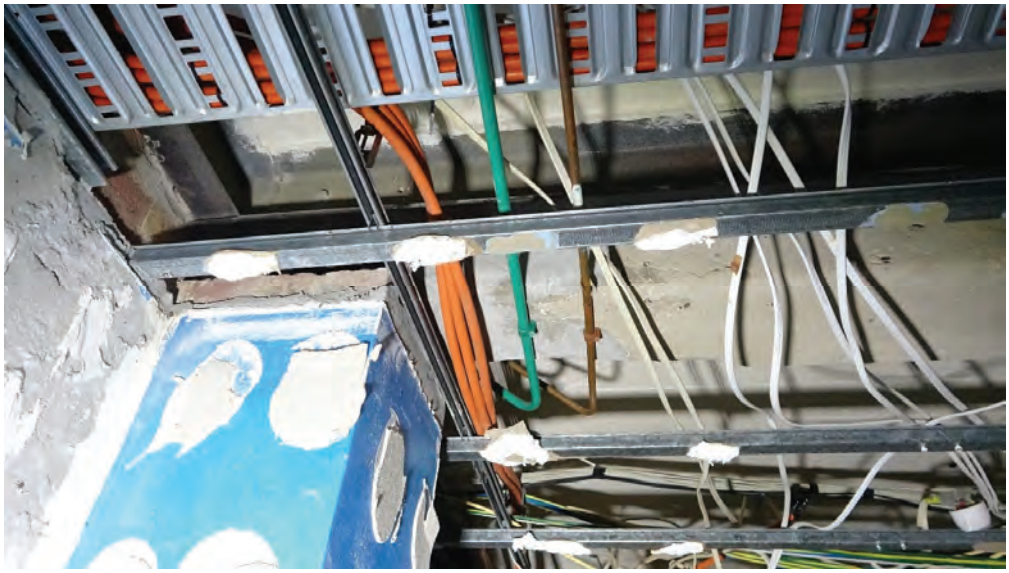
P19: Beam CB2 at 4:Q/R Shows 2 lots of repair patching.

P20: Beam CB2 at 4:Q/R Close up of repair on left hand side of beam in Photo 19 above. Note repair patch to beam soffit and side face. Also note surface rust on PFC Side Beam.

P21: Beam CB2 at 4:Q/R Close up of Right hand side of beam repair in Photo 19 above. Note repairs to soffit and side face of concrete beam, also missing render, rusty insert, chips and holes in render etc. Also note surface rust on steel side beam.

P22: BeamCB2 at 4:R/Q Opposite side of the above photo. Note repair patches, delaminating render, exposed concrete, rusty insert, etc. Also note rust on flange of PFC.

P23: Beam CB2 at 4:R Note repair patch to soffit and side face.



P24: Beam CB2 at 4:R taken from the other side to the above photo. Note repairs and cracks in side face.

P25: Beam CB2 at 4:S/U Note delamination starting in the middle then the repair patch beyond the column.

P26: Beam CB2 at 4:T Note close up of repair patch mentioned in photo P22 above.

P27: Beam CB2 at 4:V/T Cracks and chips in beam render and concrete beam.

P28: Beam CB2 at 4:V/W Note chips off edges, exposed aggregate, cracks in render etc.

P29: Beam CB2 at 4:W on post support. Note pitting and rust on SHS and cap plate. Note Cracks in rendered concrete beam soffit.

P30: Beam CB2 at 4:K/J Soffit. Note cracks and penetrations in render and beam.

P31: Northern end of Beam CB1. Base of beam completely spalled beyond reinforcement, severe corrosion to reinforcement, more cracks evident and further spalling likely.

P32: Southern end of Concrete Stair beam in toilet area CB1.

P33: Close up of Beam CB1 from above photo P31 shows water ingress, spalled concrete, corroded bars.

3.0 DISCUSION

Concrete beam CB1 in the toilet area is clearly not fit for purpose. The concrete has undergone significant spalling and has other cracks that appear as though more sections are about to break off. Reinforcement is exposed, severely corroded has begun delaminating and suffered sectional loss. The beam is being supported by propping, has no residual life and is considered to be in need of extensive repairs or replacement. (See condition assessment by BG&E).

The Southern concrete stairs already have concrete delamination on the sofit and the entire area including the platform is currently sheeted and propped. The supporting concrete beam CB-1 has spalled, exposed and rusted reinforcement with significant section loss. See Photos in Suspended slab report also. This stair supports foot traffic to the ramp and should be rectified as a matter of priority. Propping should only be a temporary measure.

Additional testing showed that carbonation had reached the steel reinforcement in beam CB2. In a several locations, cracks in the concrete and lifting of the concrete were evident, indicating that the corroding steel has already begun expanding. If not addressed this leads to spalling of concrete, delamination of steel and ultimately loss of structural integrity of the beam and its ability to carry the applied loads.

The beam also has numerous previous patch repairs, removal of the repair revealed corrosion of reinforcement, so it would only be a matter of time before the repair material begins to spall. It is expected that all the existing repairs are at risk of the same.

It was noticed that there was a crack at the shear ligature and there were similar regular cracks along the side face of the beam at regular intervals of 300 to 400mm. So a ligature spacing of 300 to 400mm has been adopted for calculation purposes.

The steel side beams supporting CB2 between grids C-K and P-W appear to have surface rust and pitting in some places.

Summary of issues:

1. **Slab topped – significant extra load:**
   Extra dead load on beam. See hatched area on drawing SK02 in appendix or Figure 4 above.

2. **Original walls removed:**
   Refer to plan SK01 in appendix or Figure 2 above which shows original walls removed in green.

   All or part of the supporting brick walls along grids L and N were removed and not replaced. See plan for clarification.

3. **Cracking and delamination of beam render in some areas:**
   See photos and locations below. Note only major ones shown, other smaller defects are present.

4. **Evidence of previous patch repairs:**
   Previous patch repairs exist at a number of locations, investigation at one of these areas showed rusting reinforcement and carbonation to reo depth.

5. **Leaks/water ingress:**
   See report on leaks – some areas of steel side beams also have increased corrosion from water ingress. See photos.

6. **No connection of wall to suspended slab:**
   There appears to be no connection between the top of the retaining wall and the suspended slab. Vertical bars were exposed at a few locations and they stopped and hooked over within the wall and did not extend across the joint into the suspended slab.

7. **Load path to side beam:**
   Existing bolts to steel side beams may not be adequate.

8. **Lack of shear reinforcement:**
   Not so much of an issue where the steel PFC side beams are provided the bolts and bolt spacing is adequate to transfer load. But the section of beam between grids K and N where existing perpendicular support walls were removed does not have side beams.

9. **Inserts, attachments, metal bolts and drill holes into side and soffit of beam:**
   Provide pathway for chloride ingress/corrosion.

10. **Carbonation of beam:**
    See Acor and Covey Joint Report on Concrete Beam Testing. (Appendix J of *Main Structural Report*). Also see BG& E Condition Assessment Report in Appendix H of *Main Structural Report.*

11. **Corrosion of reinforcement:**
    Corroded reinforcement was found at previous repairs and another random breakout.

12. Beam CB1:
Base of beam is completely gone, spalled, reo exposed and corroded. Unable to support stair load and suspended slab above. Currently propped.

4.0 STRUCTURAL ANALYSIS

Concrete beam CB1 was acting as a deep beam – which would have been adequate to support the stair load in the 1930's. However, the bottom (currently exposed) reinforcement is not restrained by shear ligatures and hence does not comply with current standards. Also there is not enough shear reinforcement as required by the current Australian standards. Nor is there enough reinforcement to meet crack control requirements. Assuming CB1 is intact, it would still need strengthening to meet requirements of the current Australian Standards.

A structural analysis was carried out. CB2 was analysed as a continuous beam to current Australian standards load combinations. The beam failed in bending and shear and would not work without the PFC side support beams.

The section of beam CB2 along 3:K to 3:P had a support wall on grid N removed and was not replaced, instead a steel post was installed on grid P. The bottom reinforcement could have a join in it over the original wall. If this is not lapped sufficiently then the steel cannot develop the stress sufficiently. Strengthening is required either by Carbon Firbre Reinforced Polymer Strips (CFRP) or steel PFC side beams. Due to shorter spans this section of beam also only just passed the bending requirements but failed in shear. If a superimposed dead load was included, then the beam would also fail in bending. Hence strengthening is required in addition to durability remedial works.

See BG&E report for service and durability assessments.

The steel side beams were checked and the B3 – 200PFC appears adequate in strength (assuming no superimposed dead load). It is unknown if the connection of the side PFC beams to the concrete is via chemical anchors or mechanical anchors and the embedment depth is also unknown. So, the capacity could range from 13kN to over 40kN which means it may actually fail in the first case.

No structural analysis on the suspended stair could be carried out as access to the soffit to scan for reinforcement was prohibited by the ply sheeting and props. Depending on the reinforcement layout the stair could span between the rear retaining wall and the concrete beam CB1. However, beam CB1 is propped and needs repair or replacement so this load path is unavailable.

5.0 REMEDIAL OPTIONS

Note that items that are not replaced must have strengthening. The extent of carbonation and steel corrosion means that localised patch repairs are no longer suitable.

5.1 Option-1: Do Nothing

Not recommended from strength and durability perspectives. Also the beam CB2 doesn't meet code requirements and does not have enough strength so it cannot be left as is – something must be done. Also beam CB1 must be remediated or replaced.

5.2 Option-2: Replacement

The beam CB2 could be replaced in conjunction with the option for replacing the entire suspended slab (and most likely the back retaining wall). This would mean that the beam would be demolished along with the slab and replaced with new reinforced concrete slab/beam while the other parts of the structure including footings, columns, ground floor slab and the roof frame can be saved. In this option, the construction procedure would be very critical as it involves demolition works whilst parts of the structure are undergoing construction. The construction procedure would involve temporary works whilst carrying out the demolition works, and progressive construction works for the new suspended slab.

It is highly likely beam CB1 will need replacing. There is a small chance that the top of the beam (exposed at the top stairs) can be remediated and kept using methods in option 3 and 4 below. This will only be required if the suspended stair slab is also salvageable.

5.3 Option-3: Remedial Works and Strengthening

As mentioned above, at CB1 the concrete has undergone significant spalling and has other cracks that appear as though more sections are about to break off. Reinforcement is exposed, severely corroded has begun delaminating and suffered sectional loss. This reinforcement is not suitable for re-use and should be replaced. All carbonated and Chloride affected concrete must be removed.

Stair soffit and concrete beam CB2 requires remediation works including removal of the carbonated concrete to the soffit of the slab and cleaning of the corroded steel where it is corroded or replacing of the corroded steel with new steel if practical and applying anti-rust coating to the remaining steel, apply bonding agent to the surface of old concrete and finally applying the new concrete to the soffit of the slab (For full details of concrete repair specification and procedure of repair works refer to Appendix D).

With regards to removal of the carbonated concrete to the soffit of the slab the following options could be investigated:

1) Hammer and chisel;
2) Use breaker;
3) Sand blasting; or
4) Water blasting.

The water blasting options as proposed by Sika Australia (refer to Appendix E for Sika Method Statement on concrete repairs specification and concrete removal using water blasting) could be considered as an efficient option and can be used in the following areas:

- Water blasting with low pressure (for cleaning)
- Water blasting with high pressure (for roughing); and
- Water blasting with very high pressure (for concrete removal)

Once the carbonated concrete is removed and replaced with new repair concrete, an anti-carbonation coating should be applied to the sofit of the slab to protect the slab from further carbonation of concrete.
Note that the steel side beams will need to be detached from the concrete beam CB2 and removed to gain access to carry out the above remediation works. The works will also need to be staged and various areas of the beam and slab propped.

These concrete and steel remedial works must be done in conjunction with strengthening works in order to carry the design loads of the building as detailed below.

Following the remedial works, strengthening is required to ensure the concrete beam can carry the design loads and comply with the Australian standard for concrete structures AS3600. The strengthening works could include CFRP (Carbon Fibre Reinforced Polymer) strengthening to the soffit of the beam and wrapping the sides of the beam to replace the corroded bottom reinforcement and insufficient/corroded shear reinforcement. Alternatively new steel reinforcement and ligs at closer centres could be installed although this would require removal of most of the concrete. Or could include adding steel beams and columns to provide additional supports to the existing beam. These strengthening options need to be detailed designed in the next stage of the work accordingly to ensure the structure can withstand the full design loads.

5.4 Option-5: Cathodic Protection

This option could be provided as an adjunct to strengthening, but corrosion of reinforcement is already evident hence this option is unlikely to be feasible.

5.5 Option -6: Remedial works for steel side beams

Remedial procedure for each steel side beam should include but not be limited to:

- Detach the PFC from the concrete beam. Thoroughly clean and remove all corrosion and rust products,
- wire brush/mechanically grind surfaces to achieve smooth and bright metal comparable to class 2.5,
- check for sectional loss,
- weld in strengthening plates or replace beam if required,
- replace connection plates if required,
- apply primer and coating system to manufacturers specification and warranty
- reinstall side support beams if required.
- re-apply at end of warranty period or next maintenance period as required.

6.0 OTHER CONSIDERATIONS

Other considerations include but are not limited to:

- Removal of the steel support beams to fully access the suspended slab sofit for concrete removal.
- Staging of the works, removal and cleaning the steel support framing must be done in stages and the slab propped while beams are removed.
- Likewise, any concrete removal and repairs of the underside of the slab will need to be done in stages
- Many of the steel beams are welded together and only bolted to the rear retaining wall, hence removal of these beams will require on site steel cutting then retrofitting bolted connections and/or site welding.
- Installation of new concrete may be done with a high flow mix requiring formwork.

7.0 CONCLUSIONS

With regards CB1 – there might not be much of it left to remediate once all the carbonated and chloride affected concrete is removed. It is likely that this beam will need to be replaced. This affects the supported element being the suspended stair and landing.

CB2 requires strengthening and remedial works.

The supported stair and landing also require remedial works and most likely strengthening.

8.0 LIMITATIONS:

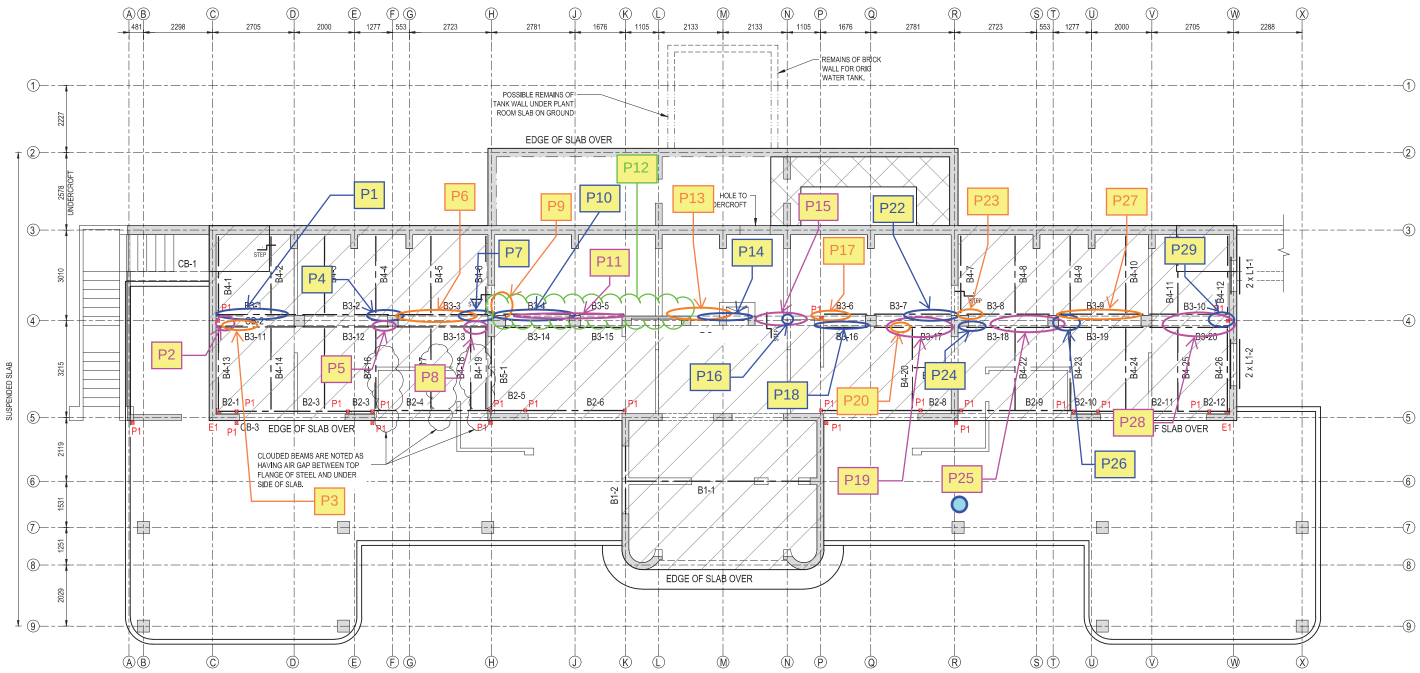
The proposed remedial works above are only a high level recommendation and require a full detailed design and further investigation before any construction works can be carried out. Data from others has been relied upon, quoted and used in analyses carried out.

The opinions, conclusions and any recommendations in this report are based on information from, and testing undertaken at or in connection with, specific sample points. Site conditions in other parts of the site may be different to those found at the specific sample points.

The opinions, conclusions and recommendations in this report are based on the assumptions made by Engineers as described in this report. Covey Associates and ACOR Consultants disclaims any liability arising from any of these assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on the conditions encountered and information reviewed at the date of preparation of the report. Covey Associates and ACOR Consultants has no responsibility or obligation to update this report to account for events or changes subsequent to the date the report was prepared.

APPENDIX A
REFERENCE PLAN SHOWING PHOTO LOCATIONS
BEAM ON GRID 4



STRUCTURAL ELEMENT - IDENTIFICATION			
ID	DESCRIPTION	MATERIAL	ORIGIN
P1	100 SHS	STEEL	POST 2000
EA1	150x10 EA	STEEL	POST 2000
B1	360UB 50.7	STEEL	POST 2000
B2	250PFC	STEEL	POST 2000
B3	200 PFC	STEEL	POST 2000
B4	180 PFC	STEEL	POST 2000
B5	150PFC	STEEL	POST 2000
L1	100EA x 6	STEEL	POST 2000
CB-1	GRID A - C	CONCRETE	ORIGINAL
CB-2	GRID C - W	CONCRETE	ORIGINAL
CB-3	GRID C - W	CONCRETE	

NOTE:

ALL DIMENSION ARE BASED OFF SCANNED PDF FROM 1937 ARCHITECTURAL SKETCHES, ROUGH SITE MEASURES. DIMENSIONS ARE APPROXIMATELY +/- 100mm
FOR MORE ACCURATE PLANS SEE DRAWINGS PRODUCED BY 3D CLOUD POINT (BY OTHERS).

REFERENCE PLAN - SHOWING LOCATIONS OF PHOTOS OF PREVIOUS REPAIRS AND DEFECTS

LEGEND

- ORIGINAL 1937 ARCHITECTURAL LAYOUT
- CURRENT LAYOUT NOM. 100 mm TOLERANCE
- BEAMS OVER
- BEAMS UNDER
- UNDERCROFT WALLS
- CURRENT LOWER SUPPORTING WALLS / COL.

- HATCHED AREA INDICATES TOPPING SLAB OVER ORIGINAL SLAB
- 100mm HIGH CONCRETE PLINTH OVER ORIGINAL SLAB
- STEP — ORIGINAL STEP PRIOR TO TOPPING

Check all dimensions before commencement of work. Check Site boundary dimensions from the Title plans Check Building Boundary clearances by set out. Notwithstanding the information supplied on this drawing, the location, depth and extent of underground or overhead services are to be confirmed and protected on site by the contractor prior to commencement of works.

Checked – RG
Design – CJT Drawn – MS
Scales – AS SHOWN
Document Stage – INFORMATION

Issue	Date	Description	By
E	02.11.22	ISSUED FOR INFORMATION	TW
D	01.11.22	ISSUED FOR INFORMATION	TW
C	24.08.22	ISSUED FOR INFORMATION	RG
B	20.07.22	ISSUED FOR INFORMATION	CJT
A	15.07.2022	ISSUED FOR INFORMATION	MS

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Approved

Drawing title – PAVILLION 1 UPPER FLOOR FRAMING STRUCTURE

Project – SUTTONS BEACH PAVILIONS

Client – MORETON BAY REGIONAL COUNCIL

Site – SUTTONS BEACH, REDCLIFFE, QLD, 4021

Project No. 223164 Sheet No. SK102
Digital Ref : 223164_SK102 FLOOR FRAMING STRUCTURE Issue : E

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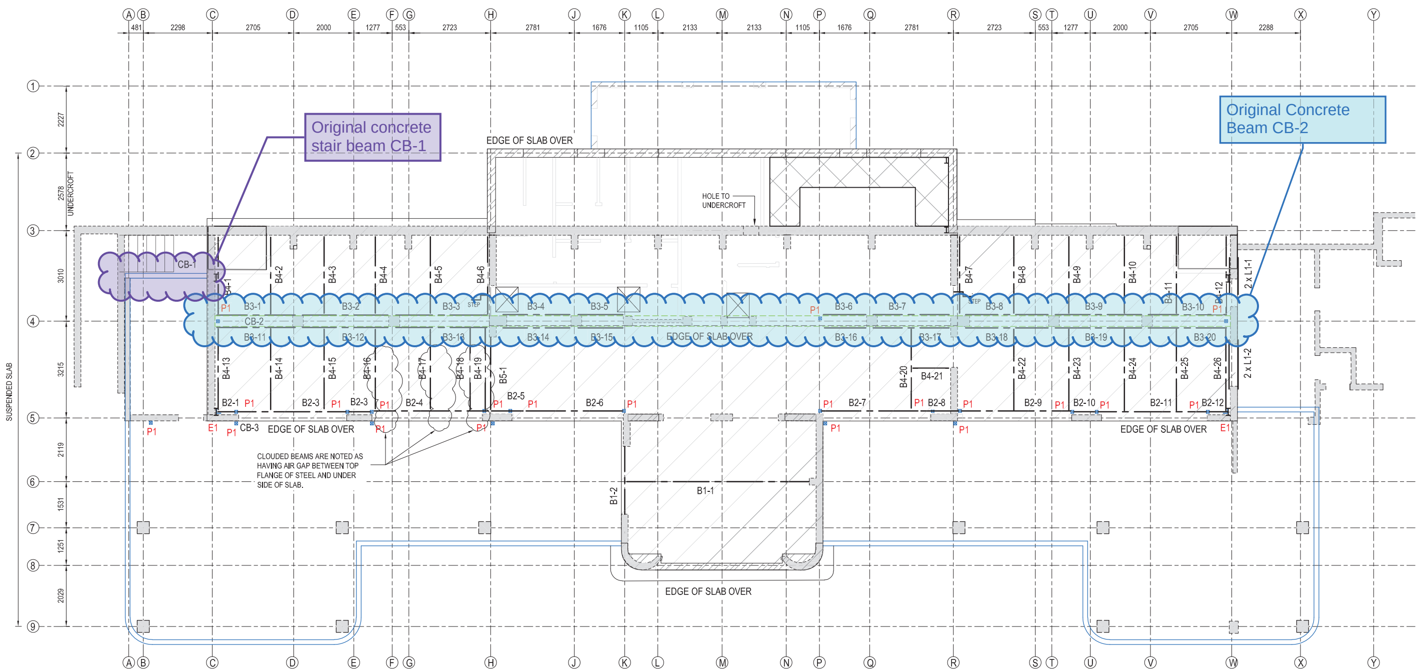
Plot 04 Nov, 2022 - 09:25

APPENDIX B
LOCATION PLAN



UPPER FLOOR - SLAB FRAMING PLAN

SCALE A1 - 1:62.5
SCALE A3 - 1:125

STRUCTURAL ELEMENT - IDENTIFICATION

ID	DESCRIPTION	MATERIAL	ORIGIN
P1	100 SHS	STEEL	POST 2000
EA1	150x10 EA	STEEL	POST 2000
B1	360UB 50.7	STEEL	POST 2000
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B3	200 PFC	STEEL	POST 2000
B4	180 PFC	STEEL	POST 2000
B5	150PFC	STEEL	POST 2000
L1	100EA x 6	STEEL	POST 2000
CB-1	GRID A - C	CONCRETE	ORIGINAL
CB-2	GRID C - W	CONCRETE	ORIGINAL
CB-3	GRID C - W	CONCRETE	

NOTE:

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LEGEND

- CURRENT LAYOUT NOM. ±100 mm TOLERANCE
- ORIGINAL BEAMS SUPPORTING SLAB
- STEEL BEAMS SUPPORTING SLAB
- UNDERCROFT WALLS
- CURRENT LOWER SUPPORTING WALLS / COL.

- HATCHED AREA INDICATES TOPPING SLAB OVER ORIGINAL SLAB
- 100mm HIGH CONCRETE PLINTH OVER ORIGINAL SLAB
- NEW CONCRETE SLAB OUTLINE

Check all dimensions before commencement of work. Check Site boundary dimensions from the Title plans Check Building Boundary clearances by set out. Notwithstanding the information supplied on this drawing, the location, depth and extent of underground or overhead services are to be confirmed and protected on site by the contractor prior to commencement of works.

Checked – RG
Design – CJT Drawn – MS
Scales – AS SHOWN
Document Stage – INFORMATION

Issue	Date	Description	By
F	21.11.22	LAYOUT AMENDED	SAG
E	02.11.22	ISSUED FOR INFORMATION	TW
D	01.11.22	ISSUED FOR INFORMATION	TW
C	24.08.22	ISSUED FOR INFORMATION	RG
B	20.07.22	ISSUED FOR INFORMATION	CJT
A	15.07.2022	ISSUED FOR INFORMATION	MS

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Project – SUTTONS BEACH PAVILIONS

Client – MORETON BAY REGIONAL COUNCIL

Site – SUTTONS BEACH, REDCLIFFE, QLD, 4021

Project No. 223164 Sheet No. SK102

Digital Ref : 223164_SK102 FLOOR FRAMING STRUCTURE Issue : F

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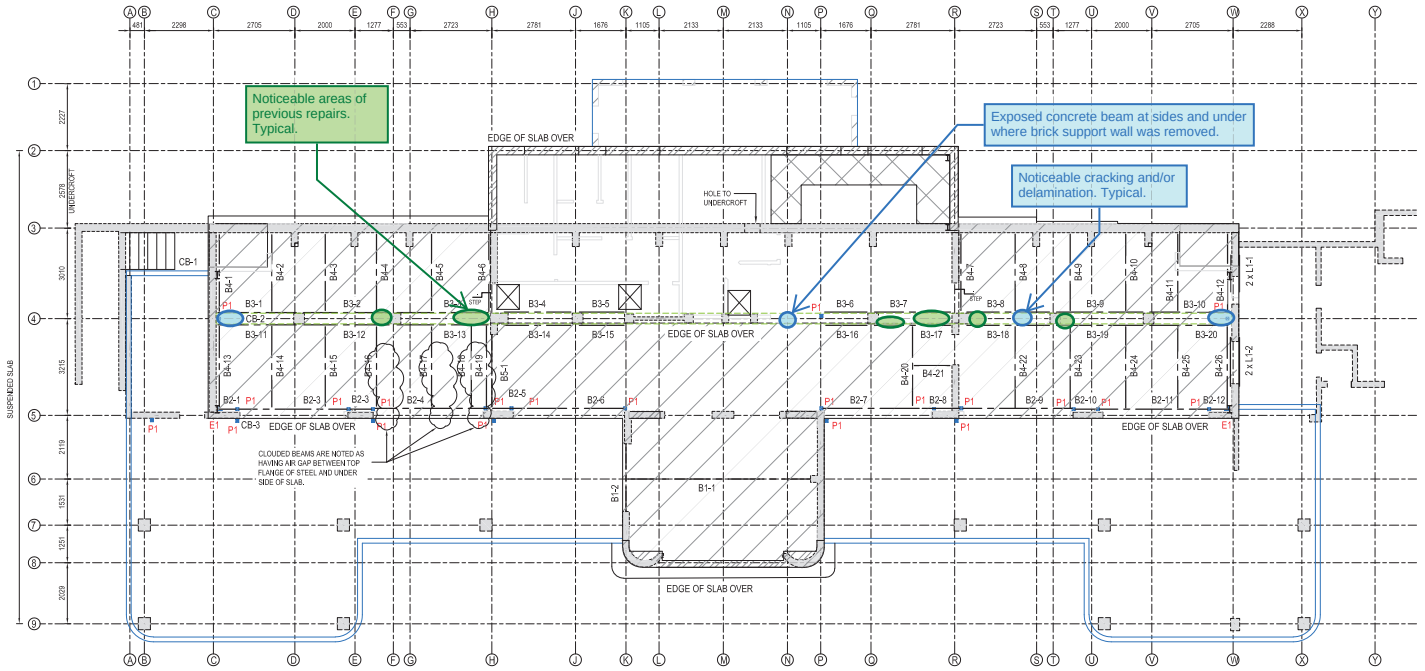
Plot 21 Nov, 2022 - 13:23

APPENDIX C
PREVIOUS REPAIR LOCATIONS



UPPER FLOOR - SLAB FRAMING PLAN

SCALE A1 - 1:62.5
SCALE A3 - 1:125

STRUCTURAL ELEMENT - IDENTIFICATION			
ID	DESCRIPTION	MATERIAL	ORIGIN
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L1	100EA x 6	STEEL	POST 2000
CB-1	GRID A - C	CONCRETE	ORIGINAL
CB-2	GRID C - W	CONCRETE	ORIGINAL
CB-3	GRID C - W	CONCRETE	ORIGINAL

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LEGEND

- CURRENT LAYOUT NOM. ±100 mm TOLERANCE
- ORIGINAL BEAMS SUPPORTING SLAB
- STEEL BEAMS SUPPORTING SLAB
- UNDERCROFT WALLS
- CURRENT LOWER SUPPORTING WALLS / COL.
- HATCHED AREA INDICATES TOPPING SLAB OVER ORIGINAL SLAB
- 100mm HIGH CONCRETE PLINTH OVER ORIGINAL SLAB
- NEW CONCRETE SLAB OUTLINE

Check all dimensions before commencement of work.
Check Site boundary dimensions from the Title plans
Check Building Boundary clearances by set out.
Notwithstanding the information supplied on this drawing, the location, depth and extent of underground or overhead services are to be confirmed and protected on site by the contractor prior to commencement of works.

Checked – RG	F	21/11/22	LAYOUT AMENDED
Design – CJT Drawn – MS	E	10/11/22	ISSUED FOR INFORMATION
Scales – AS SHOWN	D	01/11/22	ISSUED FOR INFORMATION
	C	24/08/22	ISSUED FOR INFORMATION
	B	29/07/22	ISSUED FOR INFORMATION
Document Stage – INFORMATION	A	15/07/2022	ISSUED FOR INFORMATION
	Issue	Date	Description / By

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Site – SUTTONS BEACH, REDCLIFFE, QLD, 4021

Project No. 223164 Sheet No. SK102
Digital Ref : 223164_SK102 FLOOR FRAMING STRUCTURE Issue : F

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Plot 21 Nov, 2022 - 13:29

APPENDIX D
EXAMPLE - CONCRETE REPAIR SPECIFICATIONS

A.1 Concrete Repair Specification

A.1.1 General

The Contractor shall undertake concrete repairs to the building reinforced concrete slab or other concrete members as per following procedure and specification.

All works shall be in strict accordance with *HB 84:2018 Guide to Concrete Repair and Protection NCC/BCA* (National Construction Code / Building Code of Australia), and relevant Australian Standards.

A.1.2 Scope of Works

The scope of works is repair of all reinforcement corrosion related deterioration to the concrete, including but not limited to:

- Protection to adjacent fixtures and finishes
- Removal and disposal of all existing drummy and delaminated concrete, including any render coatings;
- Break-out of concrete around reinforcement to the requirements of the Specification;
- Treating all exposed reinforcement with a primer system;
- Replacement of severely corroded reinforcement as directed by the Superintendent; and
- Reinstatement of broken-out areas with a cementitious repair mortar.

A.1.3 Inspections

1. HOLD POINT: At completion of the mark-out and repair schedule for submission and approval by the Superintendent.
2. WITNESS POINT: Where the breakout indicates that the surrounding concrete is not sound; or if the reinforcement is corroded at the boundary of the breakout.
3. HOLD POINT: At completion of the break-out and tallying of break-out quantities.
4. HOLD POINT: At completion of cleaning of corroded and exposed steel surfaces to achieve a minimum steel preparation equivalent to AS 1627.4 Class Sa 2½.
5. HOLD POINT: A completion of surface preparation but prior to priming.

A.1.4 Materials

The materials used for the concrete repairs shall comprise the following components:

1. Hand applied repair mortar or poured micro concrete;
2. Zinc-rich reinforcement primer system; and
3. Curing compound (if required).

The repair materials shall be a proprietary system intended for concrete repair. Products equal in performance to the following are considered to be suitable:

- Renderoc HB40 by Fosroc
- Monotop 352NFG by Sika
- Nitoprime Zincrich by Fosroc
- Monotop®-910 N by Sika
- Nitobond HAR

- Concure A99.

Proposed materials shall be provided for approval by the Superintendent at least two weeks prior to proceeding with the works.

A.1.5 Sample Repair

The Contractor shall prepare a sample repair for approval by the Superintendent demonstrating the level of workmanship for each component of the repair.

Sample repairs shall be ready for inspection at least one week prior to proceeding with the associated works. The Superintendent shall be notified in advance of the date when the sample works will be ready for inspection.

The sample repair shall include the procedures required for a typical repair, including:

- Break-out of reinforcement;
- Surface preparation of reinforcement;
- Priming of reinforcement;
- Preparation of concrete surfaces;
- Saw cutting to perimeter of repair areas;
- Priming of surfaces to receive repair mortar;
- Mixing of repair mortar;
- Placement of repair mortar; and
- Inspection of repair after seven days.

The sample repair is to be repeated until the Superintendent is satisfied that the manner of execution meets the required standards and approval is given to proceed.

The approved sample repair shall be referred to as the required standard during execution of the works.

A.1.6 Procedure

The repairs shall be undertaken in accordance with *HB84: Guide to Concrete Repair and Protection.* In addition, the manufacturer's instructions for the specified materials must be strictly followed. If the following specification contradicts the manufacturer's instructions in any way, refer to the Superintendent prior to commencing work.

A.1.6.1 Identification of Areas Requiring Repair

A preliminary survey of the concrete slab has been undertaken to determine the location of existing damage and to estimate provisional quantities of repair. This survey need to be finalized by a final detailed inspection by remedial engineer.

The Contractor shall identify the areas requiring repair by visual and sounding survey.

1. Inspect the concrete surface for signs of corrosion staining, cracking and spalling of concrete.
2. Undertake an acoustic sounding survey of 100% of the concrete surfaces by sounding the surface with a hammer to identify the extent of delaminated concrete at these locations and other locations across the concrete surfaces.
3. The areas requiring repair shall be marked-out on the concrete surface with permanent marker or similar for approval by the Superintendent prior to concrete breakout.
4. Photograph and measure the marked-out area and input into a repair schedule for submission and approval by the Superintendent. **HOLD POINT.**

A.1.6.2 Concrete Breakout

1. Identify location of any embedded services, such as electrical conduits and water pipes, windows, glass and other fixtures that may be affected by the works.
2. Install suitable protection to surrounding areas where breakout of concrete may result in damage of those items. If required, temporarily remove windows or other items that may be impacted by the works.
3. Check the depth of reinforcement prior to saw cutting perimeter of repair areas to ensure the reinforcement will not be damaged by saw cutting. Reinforcement that is damaged by saw cutting shall be replaced at the expense of the Contractor.
4. Provide a border to the repair by saw cutting the marked boundary of the repair areas in a series of straight lines at right angles to the surface to a nominal depth of 10mm.
5. Starting at the marked boundary of the repair, breakout the loose and delaminated concrete using light hand-held percussive equipment or other approved means.
6. The breakout shall be prepared to remove loose or weak concrete, surface laitance and other contaminants. Care shall be taken so as not to damage reinforcement, adjacent sound concrete or fixtures. Take care not to break through the full thickness of the slab or concrete element.
7. Do not extend the size of the repair without approval. Ensure the marked boundary remains visible following breakout.
8. Concrete shall be removed around the full perimeter of the corroded reinforcement for a minimum distance of 25mm measured radially outward from the surface of reinforcement. Ensure there is sufficient space around the bar to allow thorough cleaning of the full perimeter of the reinforcement.
9. Notify the Superintendent where the breakout indicates that the surrounding concrete is not sound; or if the reinforcement is corroded at the boundary of the breakout. **WITNESS POINT.**
10. Subject to approval by the Superintendent, introduce fresh saw cuts 50mm along the reinforcement and breakout the concrete such that the length of breakout along the reinforcement exposes continuous length of 50mm of steel free from active corrosion.
11. Where possible, reposition reinforcement to provide a minimum concrete cover of 30mm. Where this is not possible, seek direction from the Superintendent who may specify alternative repair methods. Any straight bar ends (not cogged) with less than 30mm cover may be cut or ground back to achieve 30mm cover.
12. Notify the Superintendent if any reinforcement has lost over 10% of its diameter due to corrosion or damage. Affected reinforcement shall be replaced in accordance with Clause A.1.6.4 as directed by the Superintendent.
13. Any tie wire, nails, screws, bolts or other metallic components on or near the surface of the concrete shall be removed or the concrete surrounding the metallic component removed and the metallic component cut back a minimum of 10mm.
14. When the full extent of repair has been finalised, ensure that the full perimeter of the repair area has saw cuts installed. Feathered edges to the repairs are not acceptable.
15. The exact size of the breakout shall be photographed and recorded by the Contractor for approval by the Superintendent.
16. The reinstatement work shall not proceed until the breakout has been inspected, the quantities approved by the Superintendent, and approval given to proceed. **HOLD POINT.**
17. The Contractor shall dispose of all material resulting from the demolition process in accordance with Clause **Error! Reference source not found.**.

A.1.6.3 Reinforcement Preparation and Treatment

1. Reinforcement that has lost over 10% of its diameter (as evident once cleaned back adequately for assessment) shall be replaced as directed by the Superintendent.
2. The Contractor shall report to the Superintendent any reinforcement that has been damaged by the work. The Superintendent shall provide further instruction if any additional/replacement reinforcement is required.
3. Corroded and exposed steel surfaces shall be cleaned around the full perimeter of the bar to remove all loose mill scale, corrosion products and concrete to achieve a minimum steel preparation equivalent to AS 1627.4 Class Sa 2½. **HOLD POINT.**
4. The reinforcement shall be thoroughly washed in potable water and allowed to dry prior to application of the reinforcement primer.
5. The prepared and washed reinforcement shall be primed as soon as practicable with the recommended primer to a minimum dry film thickness specified by the product manufacturer and inspected after 24 hours. **HOLD POINT.**
6. If corrosion has reoccurred through the primer coating, the reinforcement preparation shall be repeated to the approval of the Superintendent at the expense of the Contractor.

A.1.6.4 Replacement of Reinforcement

New sections of reinforcement shall be welded on one side with a weld thickness half the new bar diameter. The minimum weld length shall be 10 times the new bar diameter connecting the new bar to a length of existing bar with no visible defects or loss of section. Additional concrete removal may be required to expose a suitable length of bar for welding purposes.

Alternatively, lapping of bars shall be undertaken in accordance with AS3600.

The Contractor shall submit proposed procedures and obtain the approval of the Superintendent before commencing such work.

All reinforcing steel for concrete shall consist of hot rolled plain bar and high yield deformed bar. Plain bar may be used for ligatures and/or to supplement existing plain bar only. Deformed bar shall be used for main reinforcement.

A.1.6.5 Repair Reinstatement

In addition to the manufacturer's instructions, the following shall also generally apply.

1. Determine the volume of repair material required prior to commencing works so as to ensure that the repair material can be properly placed within the recommended timeframes.
2. Pre-wet the breakout so that the concrete reaches a Saturated Surface Dry condition (SSD) immediately prior to the reinstatement of repair material.
3. Mix the proprietary repair material in strict accordance with the manufacturer's instructions, using the correct volume of water and mixing for the required time. Only whole bags of material are to be used. Do not use part-bags. Do not hand-mix the material. Do not add additional water or other additives.
4. Prime the concrete using the manufacturer's recommended primer.
5. Apply the repair material in accordance with the manufacturer's instructions. Pay attention to encasing the reinforcing steel with the repair material. Compact the repair material to ensure no voids or unbonded areas are present.
6. If the repair is deeper than is recommended to be filled by a single application of the repair material, scratch the surface of each layer of material to provide a key for subsequent layers and allow to cure per manufacturer's instructions. Repeat steps 2-7 as required.

7. If the repair is to be applied over a joint in the substrate or incorporates a joint in the surrounding elements, include a corresponding joint in the repair as appropriate and match the original joint dimensions. Use a temporary joint former to achieve a neat edge at the joint.
8. If the repair is to a slab edge, then a drip groove shall be created in the repair as appropriate and match the original drip groove dimensions. The drip groove shall be located to ensure that depth of cover to reinforcing steel exceeds 30mm. Consult the Superintendent for direction where this is not possible.
9. Finish the surface of the repair to match surrounding surface level. Do not apply repair material beyond the repair boundary. Do not overwork the repair surface.

A.1.6.6 Curing of Repairs

Curing shall be provided as soon as practicable after finishing of the repair.

Curing of the repairs is required to prevent excessive drying shrinkage and ensure proper curing of the repair material.

Curing protection shall be provided to repair areas for a minimum of 7 days.

Curing shall be provided by placing heavy-duty polyethylene sheeting in intimate contact with the repair. The sheeting shall overlap the existing concrete to encapsulate the repair area and be securely fastened and sealed to limit air and water ingress.

Alternatively, subject to the approval of the Superintendent, a curing compound may be used for areas where polyethylene is impractical. Curing compounds shall conform to AS 3799 and shall be applied in accordance with the manufacturer's instructions.

Do not overcoat repair surfaces before the repair mortar has cured sufficiently or curing agents have been removed. Confirm with the coating manufacturer the earliest acceptable time when coating can commence and obtain the manufacturer's written advice of this prior to commencement of coating works.

A.1.6.7 Measuring and Reporting

The size, shape, depth, location of each repair together with a photograph shall be recorded by the Contractor in a weekly report.

The volume of repairs shall be measured based on the volume of repair material used. The volume shall be determined based on the number of bags of repair material used for the repairs.

The Contractor shall provide records of the number of bags used and delivery dockets from the material supplier to justify the quantity of product used.

At completion, the Contractor shall provide façade mark-ups and photos showing the areas that have been repaired and overall measurements to justify the quantity of product used.

A.1.6.8 Make Good

The Contractor shall make-good all areas, fittings, fixtures that are affected by the concrete repair works. This may include but not be limited to:

- Sealant repairs;
- Brick masonry repairs;
- Window sealing, etc.

The costs for these works shall be measured and claimed under the Provisional Quantities in the Contract.

A.1.6.9 Defective Works

The following defects in the repairs are not acceptable:

- Cracking around the perimeter of the repair;
- Cracking within the repair;
- Poor compaction or finishing;
- Delaminating or hollow-sounding repairs; and
- Evidence of the use of incorrect procedures.

Defective works shall be completely removed and reinstated at the Contractor's expense.

A.1.7 Pricing

The Contractor shall provide a LUMP SUM for concrete repairs to affected concrete surfaces as per remedial works design drawings. The final cost of the concrete repairs to these areas of the building shall be adjusted if required at the end of project.

APPENDIX E
MS REPAIRING CONCRETE

METHOD STATEMENT
Repairing Concrete Using Sika® Ready to use Mortars

JULY 2014 / V2 / SIKA AUSTRALIA

BUILDING TRUST

TABLE OF CONTENTS

1 SCOPE

This method statement describes the step by step procedure for repairing concrete structures using the Sika® MonoTop®, SikaTop® and Sika® EpoCem® range ready to use mortar products.

2 SYSTEM DESCRIPTION

The Sika® concrete repair range is a system of products consisting of a bonding primer, reinforcement corrosion protection layer; mortar repair and levelling or smoothing mortar.

USES

- Bonding primers for promoting adhesion of a repair mortar on concrete
- Reinforcement corrosion protection applied on steel reinforcement bars in concrete (principle 11, method 11.1)
- Repair and reinstatement of damaged or contaminated concrete on buildings, bridges, infrastructure and super structure works (principle 3, methods 3.1 and 3.3)
- Increasing bearing capacity of a concrete structure by adding mortar for strengthening (Principle 4, method 4.4)
- Preserving or restoring passivity of steel reinforcement bars in concrete (Principle 7, methods 7.1 and 7.2)
- Increasing cover to reinforcement bars with additional mortar
- Thin layer render
- For pore sealing or levelling a concrete surface prior to adding a protective coating
- Repair of minor defects

CHARACTERISTICS/ ADVANTAGES

- Pre-mixed for quality
- 1-component products only add water
- Adjustable consistencies
- Versatile range of performances
- Low shrinkage
- Products with easy surface finishing
- Products with classified performance classes
- Systems with high resistance to water and chloride penetration
- Products which can be hand or machine applied
- Compatible system with Sikagard® concrete protection products

2.1 REFERENCES

This method statement has been written in accordance with the recommendations contained in European Standards EN 1504: Products and systems for the protection and repair of concrete structures, and the following relevant parts:

- EN 1504 Part 1: Definitions, requirements, quality control and evaluation of conformity
- EN 1504 Part 3: Structural and non-structural repair
- EN 1504 Part 7: Reinforcement corrosion protection
- EN 1504 Part 10: Site application of products and systems, and quality control of works

2.2 LIMITATIONS

- Products shall only be applied in accordance with their intended use.
- Local differences in some products may result in some slight performance variations. The most recent and relevant local Product Sheet (PDS) and Material Safety Data Sheet (MSDS) shall apply
- For specific construction / build information refer to the Architects', Engineer's or Specialist's details, drawings, specifications and risk assessments.
- All work shall be carried out as directed by a Supervising Officer or a Qualified Engineer.
- This method statement is only a guide and shall be adapted to suit local products, Standards, legislations or other requirements.

3 PRODUCTS

Sika MonoTop®	1-component, ready to use repair mortar, bonding primer or reinforcement corrosion protection
SikaTop®	3-component, ready to use repair or levelling mortar
Sika® EpoCem®	3-component, ready to use bonding primer, reinforcement corrosion protection or levelling mortar

3.1 SYSTEM BUILD-UP

A Sika® repair system comprises a range of products to suit the needs.

Bonding Primer And Reinforcement Corrosion Protection	
Sika MonoTop®-910 N	Normal use
SikaTop®-110 EpoCem®	Demanding requirements
Concrete Repair Mortars	
Sika MonoTop®-612 N	R4 high strength mortar
Sika MonoTop®-352 NFG/N	R3 normal setting mortar
Sika MonoTop®-412 NFG/N	R4 Normal setting mortar
Sika MonoTop®-436 N	R4 Normal setting form and pour application
Pore Sealer and Levelling Mortar	
Sika MonoTop®-723 N	R3 normal use
Sika MonoTop® FC	Fairing Coat mortar
Sikagard®-720 EpoCem®	R4 demanding requirements

3.2 MATERIAL STORAGE

Materials shall be stored properly in undamaged original sealed packaging, in dry cooled conditions. Refer to specific information contained in the product data sheet regarding minimum and maximum storage temperatures.

4 EQUIPMENT

4.1 MATERIALS

Sufficient quantities Sika® repair materials	Refer to section 11
Sufficient clean water	For mixing 1-component, pre-wetting substrate & cleaning

4.2 ESSENTIAL EQUIPMENT

Hand tools	Trowels, floats, brushes for mortar application
Concrete removal	Traditional tools, hammer-drill or suitable mechanical equipment for removing damaged or contaminated concrete
Measuring cylinder	For accurate measurement of mixing water
Mixing equipment	Refer to section 11.7
Mixing bowl	~18 - 20 litres per 20 kg bag
Sponge or pressurised air (oil free)	Wipe/blow away excess water from substrate
Curing	Membrane or similar to protect fresh mortar
Cleaning	Brush, low pressure water
Waste disposal	For paper bags and excess material

4.3 ADDITIONAL EQUIPMENT

Formwork	To profile application
Sealant	For sealing formwork
Spraying equipment	Mechanical application of mortars
Cleaning Equipment	Suitable for removing corrosion off reinforcement
Suitable profile	For levelling large surfaces

4.4 MIXING EQUIPMENT

Use professional equipment for mixing SikaMonoTop®.

Single mixer with spindle paddle
small quantities

Double mixer with spindle paddles
medium quantities

Forced action pan mixer
large quantities

5 HEALTH AND SAFETY

5.1 RISK ASSESSMENT

The risk to health and safety from falling objects or defects in the structure shall be properly assessed.

Platforms and temporary structures shall provide a stable and safe area to work. Do not take any unnecessary risks!

5.2 PERSONAL PROTECTION

Work Safely!

Handling or processing cement products may generate dust which can cause mechanical irritation to the eyes, skin, nose and throat.

Appropriate eye protection shall be worn at all times while handling and mixing products.

Approved dust masks shall be worn to protect the nose and throat from dust.

Safety shoes, gloves and other appropriate skin protection shall be worn at all times.

Always wash hands with suitable soap after handling products and before food consumption.

FOR DETAILED INFORMATION REFER TO THE MATERIAL SAFETY DATA SHEET

5.3 FIRST AID

Seek immediate medical attention in the event of excessive inhalation, ingestion or eye contact causing irritation. Do not induce vomiting unless directed by medical personnel.

Flush eyes with plenty of clean water occasionally lifting upper and lower eyelids. Remove contact lenses immediately. Continue to rinse eye for 10 minutes and then seek medical attention.

Rinse contaminated skin with plenty of water. Remove contaminated clothing and continue to rinse for 10 minutes and seek medical attention.

FOR DETAILED INFORMATION REFER TO THE MATERIAL SAFETY DATA SHEET

6 ENVIRONMENT

6.1 CLEANING TOOLS / EQUIPMENT

Clean all tools and application equipment with water immediately after use. Hardened material may only be removed mechanically.

6.2 WASTE DISPOSAL

Do not empty surplus material into drains. Avoid runoff onto soil or into waterways, drains or sewers. Dispose unwanted material responsibly through licensed waste disposal contractor in accordance with local legislation and/or regional authority requirements.

FOR DETAILED INFORMATION REFER TO THE MATERIAL SAFETY DATA SHEET

7 SUBSTRATE PREPARATION

7.1 CONCRETE

The concrete substrate shall be thoroughly clean, in a good sound condition and free from dust, loose material, surface contamination and materials which reduce bond. Delaminated, weak, damaged and deteriorated concrete shall be removed by suitable means. If necessary, some sound concrete may also be removed but not to detriment of the structural integrity and only as directed by a Supervising Officer or Qualified Engineer.

Methods of cleaning, roughening and concrete removal are summarised as follows:

■ntended use □ For certain intended uses	Cleaning	Roughening	Removal
Hammer and chisel			■
Breaker		■	■
Grit and sand blasting	■	■	
Water Blasting with low pressure (max. 180 bar)	■		
Water Blasting with high pressure (max. 600 bar)		■	
Water Blasting very high pressure (max.1100 bar)			■

Appropriate tool selection will depend on the type and extent of damage as well as the substrate quality and shall be agreed with the Supervising Officer or qualified Engineer.

Note: Hydro-demolition is a preferred fast and effective method of removing concrete which can result in no micro cracks in the concrete.

As defined in EN 1504-10, water jet categories are as follows:

- Low Pressure – Up to 18 N/mm^2 (MPa) / 180 bar / ~2,600 PSI
  - Used for cleaning concrete and steel substrate
- High Pressure – from 18 to 60 N/mm2 (MPa) / 600 bar / ~8,700 PSI
  - Used for cleaning steel substrate and for removal of concrete
- Very High Pressure –from 60 to 110 N/mm2 (MPa) / 1100 bar / ~16,000 PSI
  - Used for concrete removal when low water volume is available

Where: 1N/mm^2 = 10 bar = 145 PSI (lbf/in^2)

Concrete removal shall be kept to a minimum and shall not reduce the structural integrity of the structure. Pneumatic equipment or tools which can damage concrete due to an intense vibration shall not be used.

The extent of concrete removal shall be in accordance with the chosen principle and method contained in EN 1504-9. In the case of repair and restoration the depth of contamination shall be established and taken into account when determining the depth of concrete removal.

Removal of concrete shall continue to expose full circumference of the steel reinforcement to a minimum depth of 15 mm behind the back of the bars.

Breaking out shall continue along the reinforcement until non-corroded steel is reached as directed by the supervising officer or qualified engineer.

Edges around the patch repair shall be cut at an angle of >90° to avoid undercutting and a maximum angle of 135° to reduce the possibility of de-bonding.

Surface of the concrete substrate shall be roughened to 2 mm to increase bonding which can be tested in accordance with EN 1766: clause 7.2 for horizontal surfaces.

Micro cracked or delaminated concrete including damage caused cleaning, roughening or removal techniques shall be removed or repaired if they might reduce bond or structural integrity. Micro cracks can be detected by wetting the surface and allowing it to dry. Dark lines on the dried surface indicate cracks as they retain the water.

The finished surface shall be visually inspected prior to application and can be tapped lightly using a metal hammer to detect delaminated concrete. The supervising officer or qualified engineer shall be informed immediately of any loose, cracked or damaged surfaces. In these circumstances repair materials shall not be applied without prior written consent of the supervising officer or qualified engineer.

If a smoothing coat is required the whole application surface shall be properly prepared. Appropriate cleaning procedures consist of low pressure water blasting, abrasive grit and sand blasting, or high pressure water blasting to remove a laitance layer.

7.2 STEEL REINFORCEMENT

The steel reinforcement shall be thoroughly clean and free from rust, scale, mortar, concrete, dust and other loose and deleterious material which reduces bond or contributes to corrosion. Tie wire and nails shall also be removed.

The whole circumference of the bar shall be uniformly cleaned, except where structural considerations prevent this. Cleaning shall not damage in anyway the structural integrity of the steel. Immediately notify the supervising officer or qualified engineer if there is a possibility of damaging the steel by cleaning.

Exposed bars contaminated with chloride or other deleterious material shall be cleaned by low pressure water jet (18 MPa) and checked afterwards to ensure the contamination has been totally removed.

If a reinforcement corrosion protection layer in the form of an active coating (method 11.1 as defined in the European Standards EN 1504-9) is to be applied, then the steel reinforcement shall be cleaned to Sa 2 defined by ISO 8501-1.

If reinforcement corrosion protection layer in the form of a barrier coating (method 11.2 of EN 1504-9) is to be applied, then the steel reinforcement shall be prepared to Sa 2½ defined by ISO 8501-1.

Cleaned bars shall be protected against further contamination prior to application of a reinforcement corrosion protection layer.

Loss of steel-area on reinforcement due to corrosion, or due to any other damage, shall immediately be brought to the attention of the supervising officer or qualified engineer prior to any further work. Any further action such as replacing reinforcement bars shall only be carried in accordance with the direct instruction of the supervising officer or qualified engineer. The scope of this method statement does not include replacement of steel reinforcement bars.

7.3 PRE-WETTING SUBSTRATE

Concrete surfaces shall be saturated with clean low pressure water a minimum 2 hours before application ensuring that all pores and pits are adequately wet. The surface shall not be allowed to dry before application.

Just before application, Remove excess water prior to application e.g. using a clean sponge for small areas or air pressure for large areas. Ensure there is no standing water on the surface. The surface shall achieve a dark matt appearance without glistening and surface pores and pits shall not contain water (saturated surface dry). Use pressurised air (oil free) to blow away excess water in difficult to reach areas.

8 MIXING

Mixing shall always be carried out in accordance with the recommendations contained in the latest product data sheet (PDS).

Do not use water beyond the stated maximum and minimum limits.

In determining the mixing ratio the wind strength, humidity, ambient and substrate temperature and shall be taken into consideration.

8.1 ONE COMPONENT PRODUCTS

	Product	Procedure
	**Sika MonoTop®**	■ Place minimum recommended water ratio in mixing container ■ Progressively add powder whilst mechanically mixing using low speed (maximum 500 rpm) electric drill ■ Add more water if required to suit the desired consistency and flow properties but not exceeding maximum dosage. Mix in total for minimum 3 minutes or until the material is homogenous

8.2 THREE COMPONENT PRODUCTS

	Product	Procedure
 	**Sika® EpoCem® and SikaTop®**	■ Shake thoroughly component A and B separately ■ Pour component A into component B and shake thoroughly ■ Pour mixed components A+B into mixing container and add component C progressively whilst mixing mechanically using low speed (maximum 500 rpm) electric drill ■ Mix for minimum 3 minutes until homogenous ■ Do not add water ■ Do not part mix components

9 APPLICATION

The product and system shall be appropriate for the type of substrate, structure and exposure conditions which they are required.

9.1 BEFORE APPLICATION

Working space shall be clean and tidy with no obstructions.

Record the substrate, ambient temperature and relative humidity. Check pot life information on bag or in the product data sheet and allow for climatic conditions e.g. high / low temperatures & humidity.

External applications shall be adequately protected. Do not apply mortar repair in direct sun, windy, humid or rainy conditions or if there is a risk of frost within 24 hours in unprotected areas.

Calculate the required volume for the application and then using the equation in section 10 of this method statement, calculate the yield of the product. Make sure there is enough material on job site to carry out the work.

9.2 REINFORCEMENT CORROSION PROTECTION

Where a reinforcement corrosion protection is required, apply material to the whole circumference of the steel reinforcement bar in two layers. Wait until the first layer has dried before applying the second layer. Use a mirror to inspect behind the back of the bars to ensure full coverage.

Take care not to splash or apply material on a dry concrete substrate behind the bars.

For small areas use two paint brushes to apply 2 layers and ensure full coverage. For larger areas use hopper gun aim the spray in different directions to ensue coverage behind the back of the bars.

The repair mortar shall only be applied when the reinforcement corrosion protection is hardened (wet on dry). Refer to the relevant product data sheet for more information.

9.3 BONDING PRIMER

Refer to relevant repair mortar product data sheet if a bonding primer is required. If a bonding primer is required, the substrate surface shall be pre-wetted in accordance with section 6.3.

Bonding primers can be applied by hand pressing the material firmly into the surface using a brush or using a hopper gun for larger areas.

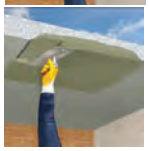
The repair mortar shall be applied wet on wet to a bonding primer. Ensure the substrate surface is fully covered behind the reinforcement bars. For large applications use only a bonding primer with long open time e.g. SikaTop®-110 EpoCem® refer to product data sheet.

9.4 HAND APPLIED REPAIR MORTARS

On a well prepared substrate, the repair mortar shall be pressed firmly in to the repair area. Ensure all the substrate pores and pits are filled.

Check pot life and adjust as necessary the water to powder ratio to suit temperature and application conditions.

When the repair depth exceeds the maximum layer thickness of the repair material, then layers may be built up on top of one another to increase the overall construction depth. The first layer shall be hardened and exothermic reaction of the material completed. The 1st layer shall be at ambient temperature before applying the second layer.



Do not smooth the first layer before applying a second layer. The first layer shall have sufficient roughness to provide a mechanical key for subsequent mortar layers.

Ensure the repair mortar covers the whole circumference of the reinforcement bars and there are no voids left behind the back of the bars.

Finish the surface with a wooden or PVC float. Do not over work the finished surface as this will produce a cement rich surface texture, which may cause the formation of random (crazing) cracking in the surface.

9.5 SPRAY APPLIED REPAIR MORTARS

Repair mortars may be applied using the wet or dry spray technique. Refer to the relevant product data sheet for information relating to spraying. Before using any spray equipment, always read the manufacturers information before starting.

Sprayed mortars are generally applied through a nozzle (Diameter subject to maximum grain size of sprayed material. Refer to machine manufacturer's information) at an angle as close as 90° to the substrate as possible. The application distance between the nozzle and substrate is approximately 200 – 500 mm for the wet spray technique and 600 – 1000 mm away for the dray spray technique.

When spraying ensure the mortar covers the whole circumference of the reinforcement bars leaving no voids behind the back of the bars.

Do not exceed the specified maximum layer thickness of the repair mortar. If necessary, test the spray on an area before starting the main application.

In the case of wet spraying adjust as necessary the water to powder ratio to suit temperature and application conditions.

When the repair depth exceeds the maximum layer thickness of the repair material, then layers may be built up on top of one another to increase the overall construction depth. The first layer shall be hardened and exothermic reaction of the material completed. The 1st layer shall be at ambient temperature before applying the second layer. Do not smooth the first layer before applying a second layer. The first layer shall be cleaned using low pressure water or compressed air before applying subsequent mortar layers.

Finish the surface with a wooden or PVC float. Do not over work the finished surface as this will produce a cement rich surface texture, which may cause the formation of random (crazing) cracking in the surface.

9.6 SMOOTHING / LEVELLING MORTARS

Smoothing mortars can be applied by hand, by hopper gun or by mechanical spray equipment for large areas. Refer to relevant product data sheet for further information.

A smoothing coat shall be applied over the whole prepared concrete surface (including repair and non-repaired areas). Any laitance layer on the surface shall be removed (section 6.1) and surface pre-wet in accordance with section 6.3.

Wait until the repair material has properly hardened before applying a smoothing coat.

Use a toothed trowel to apply the mortar by hand in a vertical direction onto the surface. Hold the trowel at an acute angle to the surface and use different size toothed trowels to regulate the application thickness.

Toothed Trowel Size	Approximate Application Thickness	
	30°	45°
10 mm	~ 5.0 mm	~ 7.0 mm
5 mm	~ 2.5 mm	~ 3.5 mm
2 mm	~ 1.0 mm	~ 1.5 mm

Table 1 Approximate application thickness guide

When 1st layer is hard, apply the second layer between the vertical lines. The hardness can be tested by the ease at which a finger nail can be inserted into the mortar.

Finish surface with damp sponge, wooden or plastic float after material has set. Do not add apply additional water on the surface as this will cause discoloration and cracking.

9.7 CURING

Cure with proper curing methods for 3 days or spray with appropriate curing compound (once any surface water has evaporated) or appropriate curing method. Curing methods include jute and water, plastic sheets or other suitable membranes.

The application shall be protected from wind, rain, frost and direct sunlight. The curing period is dependent on climate conditions. In warm temperatures with low humidity the application shall be protected from premature drying.

9.8 APPLICATION LIMITS

- Avoid application in direct sun and/or strong winds
- Do not add water over the maximum recommended dosage
- Always check the material's pot life and adjust for climate conditions
- Temperature of the repair mortar and substrate shall not differ significantly
- Where the structure is subject to dynamic loading, it is recommended for overhead applications to use repair systems specially tested for this situation

10 INSPECTION, SAMPLING, QUALITY CONTROL

As part of "Good Practice" the contractor shall provide a QC report containing the following recommended data. For more detailed information refer to EN 1504-10 Annex A, or any other local standards or legislation which may apply.

10.1 SUBSTRATE QUALITY CONTROL - BEFORE AND AFTER PREPARATION

The following checks should be carried out before and after preparation.

Characteristic	References	Frequency	Parameters
Cleanliness of Concrete	Visual	After preparation & immediately before application	No contamination, loose particles or defects
Cleanliness of Steel Bars	DIN EN ISO 8501-1	After preparation & immediately before application	No rust, scale or contamination. [Grade Sa 2 or SA 2 ½ for methods 11.1 or 11.2]
Delaminating Concrete	Hammer Sounding	After preparation	No delaminating concrete
Roughness	Visual or EN 1766 on horizontal surfaces	After preparation	Minimum roughness 2 mm (repair area) No laitance layer (smoothing mortars)
Surface Tensile Strength of the Substrate	EN 1542	After preparation works	> 1.0 N/mm² for structural repair

Table 2 QC summary before and after preparation

10.2 BEFORE, DURING AND AFTER APPLICATION

The following checks should be carried out before during and after the application.

Characteristic	References	Frequency	Parameters
Packaging	Visual	Every bag	No damage
Dry product aspect	Visual	2 bags per 10	Loose, no lumps and not compacted
Mixed material	Visual	Every mix	Homogeneous, no lumps no un-mixed dry powder
Precipitation	Record	During application	Keep records and provide protection
Wind Strength	Record	daily	Less than 8 m/sec or provide protection
Batch Number	Visual	All bags	Keep records

Table 3 QC summary before during and after application

10.3 PERFORMANCE TESTING

The following can be used on job site to check the adequacy of the application.

Characteristic	References	Frequency	Parameters
Compressive Strength on 40x40x160 prisms	EN 12190	3 prisms per batch	Within PDS limits
Cracking	Visual	28 days after application	No cracking on application
Presence of Voids/ Delaminating	EN 12504-1 Hammer sounding or *ultrasonic testing	After application	No delaminating concrete
Adhesion Bond *(pull off) (non-laboratory performance)	EN 1542 (Acc EN 1504-10 Table A.2)	Min 3 on a test area	1.2 – 1.5 N/mm² (Structural use) 0.7 N/mm² (non-structural use)

* Optional testing

Table 4 QC summary of performance testing

11 YIELD & CONSUMPTION

The yield of a product can be determined from the following equation (assuming no wastage).

Equation: $\text{yield (litres)} = \frac{\text{(weight of powder (kg) + weight of water (kg))}}{\text{density of mixture (kg/l)}}$

Given: weight of water 1 litre = ~1 kg

Example:

Calculate consumption of a bag weighing 20 kg mixed with 3.6 litres of water, when the density of the fresh material is 2.1 kg/l.

1 bag of 20 kg yields: $\frac{(20 + 3.6)}{2.1}$ = **~ 11.2 litres of mortar**

Therefore, the number of bags required for $1m^3$ of mortar will be:

N° of bags required per $1m^3$ = (1/yield) x 1000

(1/11.2) x 1000 = **~ 89 bags**

Consumption of a product can be calculated as follows:

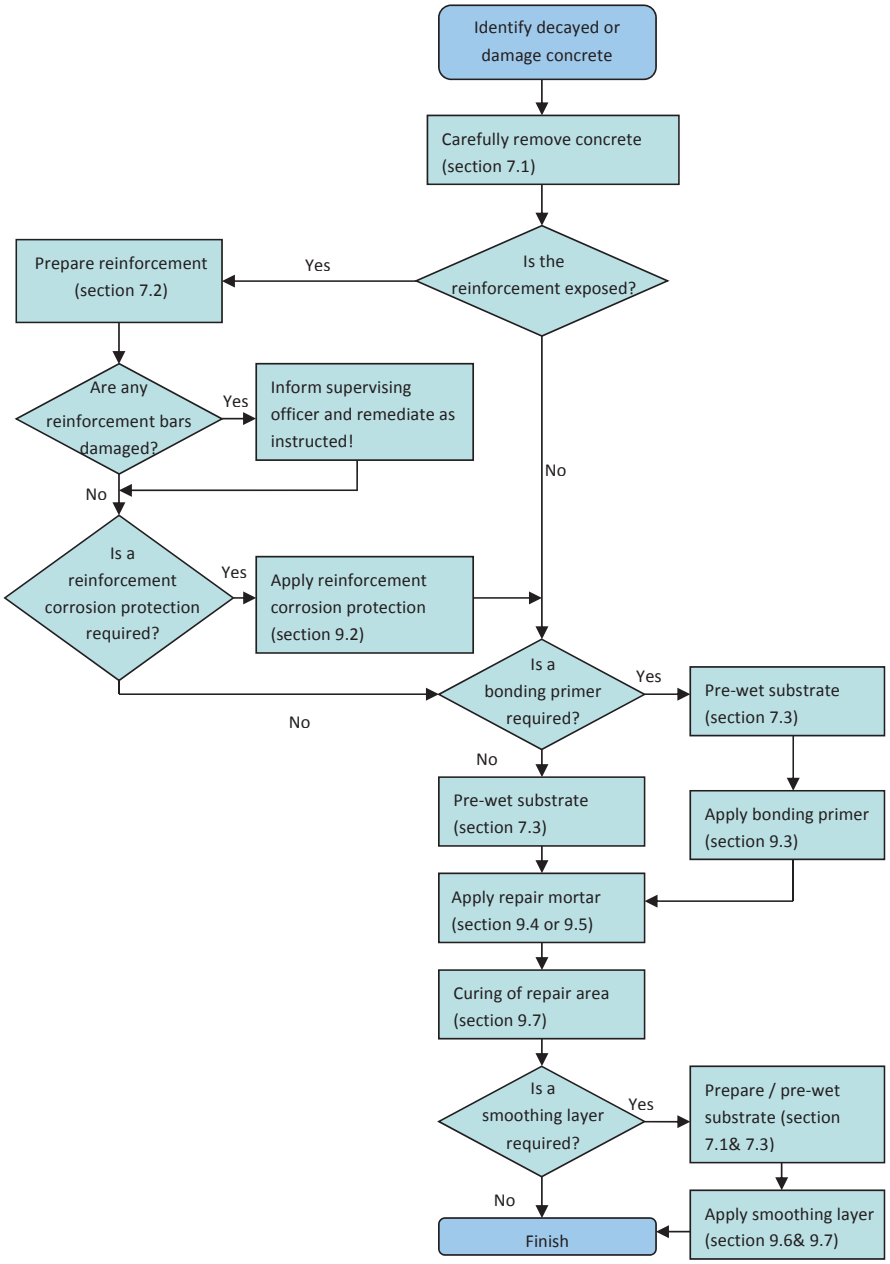
Calculate how many kg of powder is required to cover a 10 mm thick application over an area 1 m^2 (assuming no wastage)

Weight of mixed mortar (kg)	= volume (m^3) x density (kg/m^3)
	= (1 x 0.01) x 2100
	= 21 kg (total)
Less weight of water;	
If water to powder mixing ratio	= *14.5% then;
Required weight of powder	= 21 / ((100+14.5)/100)
	= **~ 18.3 kg powder**

* refer to PDS for exact figure

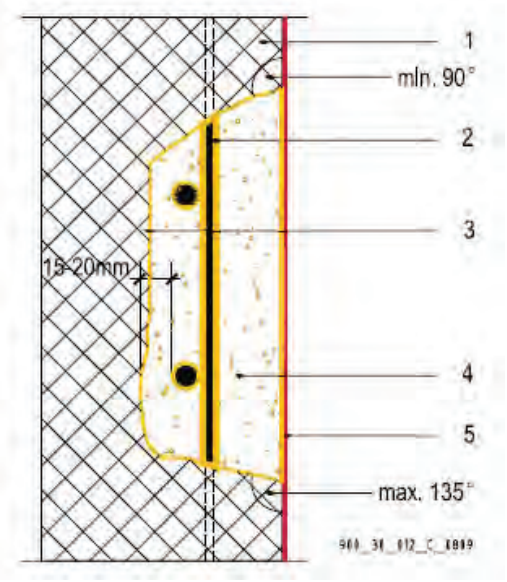
12 CONCRETE REPAIR FLOW CHART

The following is a guide of how to carrying out a concrete repair. This is not intended as a definitive guide to repair concrete and shall at all times be read in conjunction with all Architect's, Engineer's or specialist specifications together with EN 1504-10, local standards and all relevant product data sheets.



13 TYPICAL DRAWING SHOWING SYSTEM BUILD UP

This detail is for illustration purposes only and shall not be used as a construction drawing.

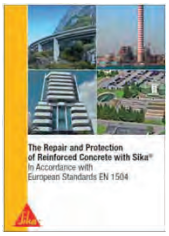


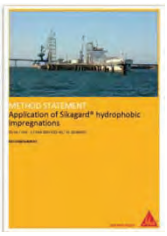
1. Host Concrete structure
2. Reinforcement Corrosion Protection Layer
3. Bonding Primer
4. Repair Mortar
5. Smoothing / Levelling Mortar

14 LEGAL NOTE

The information, and, in particular, the recommendations relating to the application and end-use of Sika products, are given in good faith based on Sika's current knowledge and experience of the products when properly stored, handled and applied under normal conditions in accordance with Sika's recommendations. in practice, the differences in materials, substrates and actual site conditions are such that no warranty in respect of merchantability or of fitness for a particular purpose, nor any liability arising out of any legal relationship whatsoever, can be inferred either from this information, or from any written recommendations, or from any other advice offered. The user of the product must test the products suitability for the intended application and purpose. Sika reserves the right to change the properties of its products. The proprietary rights of third parties must be observed. All orders are accepted subject to our current terms of sale and delivery. Users must always refer to the most recent issue of the local Product Data Sheet for the product concerned, copies of which will be supplied on request.

FOR MORE Repairing Concrete Using Sika Ready to use Mortars INFORMATION:





15 KEY WORDS

Refurbishment, method, statement, process, EN1504, Sika MonoTop, SikaTop, EpoCem, concrete, repair, damage, R4, R3, R2, hand, mechanical, spray, curing, pre-mix, reinforcement, corrosion, patch, smoothing, levelling, pore, sealing

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