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Concrete Slab and Moisture Ingress Investigation

55/25 Corella Road, Gympie QLD

*Ground penetrating radar, structural analysis,
and utility detection specialists.*



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Executive Summary

South-East Scanning was engaged to undertake a non-destructive moisture assessment and investigation of the concrete garage slab at 55/25 Corella Road, Gympie, QLD, in response to widespread efflorescence, visible cracking, and ongoing concerns about elevated moisture levels affecting the property's usability and saleability.

The investigation incorporated a combination of visual inspection, surface moisture mapping using impedance-based testing, ground penetrating radar (GPR) assessment of the slab and subgrade conditions, and a CCTV inspection of the adjacent stormwater drainage system.

The concrete slab exhibited extensive efflorescence, moisture staining, and a well-developed network of cracks across the full extent of the slab. Moisture mapping identified elevated readings across the slab, with peak values correlating directly with areas of visible efflorescence and cracking.

These findings are consistent with active moisture migration through the slab system rather than isolated surface wetting or localised internal sources.

GPR assessment identified variable reinforcement cover, anomalous shallow signal responses within the upper slab zone, and localised sub-slab anomalies consistent with potential voiding or loss of support beneath the slab. These findings suggest that the slab is not uniformly supported and may have experienced differential movement over time.



Executive Summary (cont.)

External observations identified several contributing factors, including a failed or collapsing timber retaining wall adjacent to the structure, cracking in the surrounding hardstand areas, and minimal separation between the external finished levels and the slab edge. CCTV inspection of the stormwater system confirmed that the downpipe is holding water and is cracked, indicating impaired drainage performance and the likelihood of water discharging into the surrounding subgrade rather than being effectively conveyed away from the structure.

Based on the combined findings, the observed condition of the slab is consistent with ongoing moisture ingress originating from subgrade and external site conditions. The evidence indicates that poor drainage performance and sustained moisture loading of the surrounding soils have likely contributed to subgrade instability, localised voiding, slab movement, and the development of preferential pathways for moisture transmission through the slab.

The issue is therefore considered systemic and associated with site and drainage conditions external to the slab, rather than attributable to isolated internal defects or surface-level moisture exposure. Remediation efforts focused solely on surface treatment or crack repair are unlikely to provide a durable solution without addressing the underlying drainage and subgrade conditions contributing to the problem.



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Methodology

The investigation was undertaken using a combination of non-destructive testing (NDT) techniques to assess surface moisture conditions, subsurface slab characteristics, and external contributing factors. The methodology was designed to correlate visual observations with quantitative moisture data and subsurface profiling to identify potential causes of moisture ingress.

Visual Inspection

A comprehensive visual inspection of the garage slab and surrounding external areas was conducted to identify indicators of moisture-related distress. Observations included:

- efflorescence and salt deposition patterns
- moisture staining and discolouration
- cracking distribution and severity
- slab edge and perimeter conditions
- adjacent external features, including retaining structures, drainage infrastructure, and surface levels

These observations were used to guide targeted testing and assist in interpreting moisture migration pathways.

Surface Moisture Mapping (Impedance Testing)

Surface moisture conditions were assessed using a Tramex Concrete Moisture Encounter X5 impedance-based moisture meter.

A grid-based testing methodology was adopted across the slab to provide representative coverage of the affected area. Readings were recorded at regular intervals and correlated with visible areas of efflorescence and cracking.

This method provides a comparative assessment of relative moisture content within the upper portion of the slab and is particularly effective for identifying zones of elevated moisture concentration and migration patterns.

Ground Penetrating Radar (GPR) Assessment

Ground-penetrating radar scanning was conducted using a high-frequency concrete-scanning system to assess internal slab conditions and sub-slab features.

The GPR survey was used to:

- determine reinforcement depth and distribution
- identify anomalies within the slab matrix
- assess slab thickness variability
- detect subsurface features, including potential voiding or loss of support
- identify deeper reflections consistent with beams, footings, or services

Interpretation of the radar data included analysis of both B-scan profiles and A-scan responses to identify changes in dielectric properties associated with moisture variation and subsurface discontinuities.

Stormwater Drainage Inspection (CCTV)

A CCTV inspection of the adjacent stormwater downpipe was conducted to assess the condition and performance of the drainage system.

The inspection aimed to:



- confirm whether the system was free-flowing
- identify defects such as cracking, blockage, or collapse
- assess the presence of standing water within the pipe

Findings from the CCTV inspection were used to evaluate the potential for water discharge into the surrounding subgrade and its contribution to slab moisture conditions.

Data Correlation and Interpretation

All data sources, including visual observations, moisture readings, GPR results, and drainage inspection findings, were assessed collectively to establish correlations between:

- surface moisture distribution
- cracking patterns
- subsurface anomalies
- and external site conditions

This integrated approach enables more reliable identification of moisture sources and contributing factors than any single method in isolation.

Findings

Internal Slab Conditions

The concrete garage slab was observed to be distressed, with widespread evidence of moisture ingress and associated deterioration.

Extensive efflorescence was present across the slab surface, particularly concentrated along crack lines and at slab perimeter locations. The distribution of salt deposits was non-random and consistent with active moisture migration through the slab, with moisture evaporating at the surface and leaving behind soluble salts.

Surface staining and darkened zones were observed across the slab, frequently aligned with cracking. The cracking pattern was extensive and interconnected, forming a network of pathways across the slab. The cracks varied in width and orientation and did not exhibit characteristics typical of reinforcement corrosion, instead suggesting movement-related distress.

Surface moisture mapping undertaken using impedance testing recorded elevated moisture levels across the slab. Readings ranged from approximately 3.3% to 6.9%, with the highest values consistently recorded in areas exhibiting visible efflorescence and cracking. This correlation indicates that moisture is preferentially migrating through these zones.

Ground-penetrating radar assessment identified variability in reinforcement cover across the slab, with measured cover ranging from approximately 50 mm to 150 mm. This level of variability suggests inconsistent slab construction and contributes to differential moisture behaviour within the slab.

In addition, GPR data identified anomalous responses within the upper slab zone, indicating localised changes in material properties, potentially associated with moisture variation or heterogeneity within the concrete matrix. Subsurface anomalies consistent with localised voiding or loss of support beneath the slab were also identified. These findings suggest that the slab is not uniformly supported and may have experienced differential movement over time.

Deeper reflections were identified at approximately 400–450 mm depth, consistent with the presence of structural elements such as beams or footings, or alternatively subsurface services. A strip footing was inferred along the slab perimeter.

Attempts to seal cracks with epoxy injection, as reported, have not prevented the recurrence of moisture-related symptoms, indicating that the cracks are not the source of moisture ingress but rather serve as pathways for moisture to migrate through the slab.



Figure 1: Figure 1 represents the context of the work area with severe efflorescence visible across the surface, and cracking suggestive of subgrade movement or degradation.

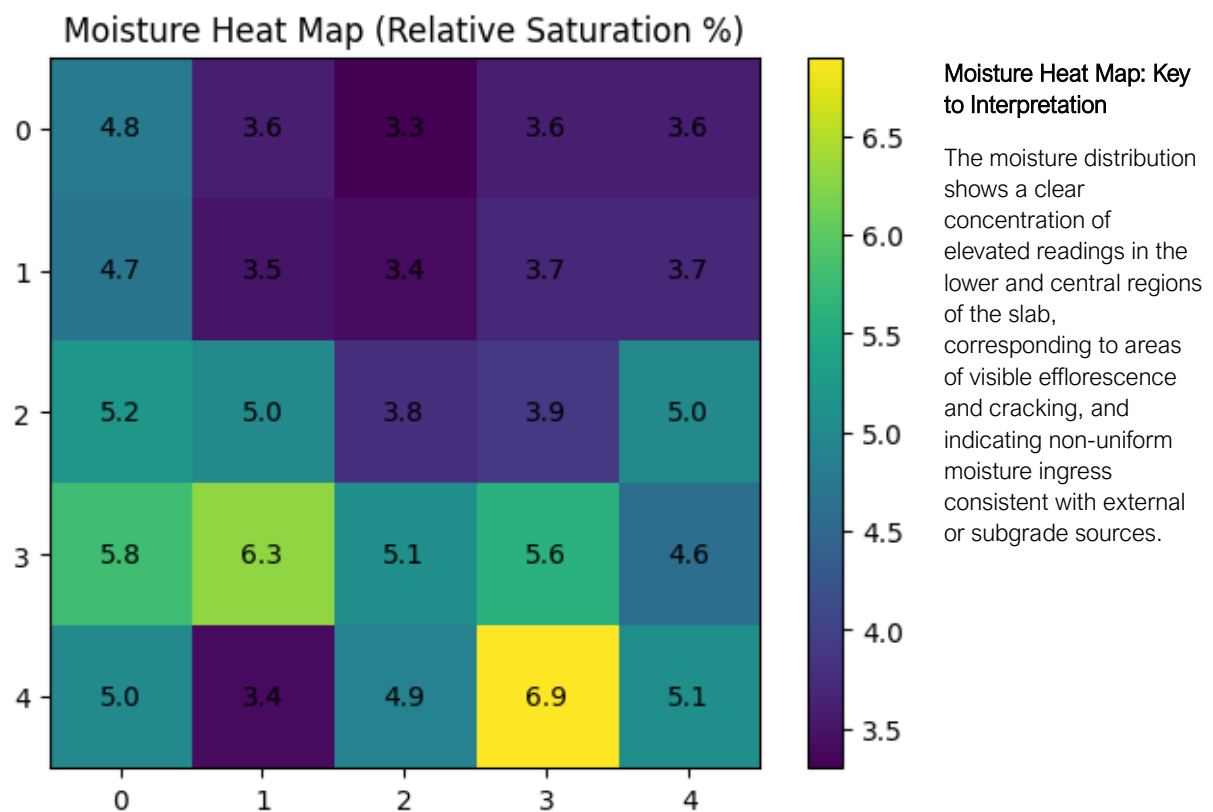


Figure 2: Moisture heat map with values indicating relative saturation across the slab.



Figure 3: Figure 3 shows a close-up of the efflorescence and cracking pattern, which, due to its non-longitudinal nature, appears to indicate subgrade movement as a cause.



Figure 4: Figure 4 shows a localised area of surface moisture accumulation and staining, characterised by darker discolouration and associated efflorescence. The irregular shape and diffuse boundaries of the wet patch are consistent with moisture migrating through the slab rather than originating from a surface spill or isolated event.

The location of the wetting aligns with surrounding cracking and areas of elevated moisture readings, suggesting that moisture is being transmitted through the slab via preferential pathways. This behaviour is consistent with sustained moisture ingress from the subgrade or adjacent ground conditions.

External Conditions and Contributing Factors

Inspection of the surrounding external areas identified several conditions likely to be contributing to the observed slab moisture and movement.

A timber retaining wall adjacent to the left side of the dwelling was observed to be in a significantly deteriorated and partially collapsed condition. The extent of deterioration suggests long-term exposure to moisture and indicates that the retained soil is likely subject to sustained saturation. This condition has the potential to increase lateral moisture loading and instability within the adjacent subgrade.

The external hardstand and driveway areas exhibited visible cracking, consistent with ground movement and differential settlement. This indicates that the observed distress is not isolated to the garage slab but is likely part of a broader site-related issue.

Finished external surface levels were observed to be near the slab level, with minimal fall away from the structure in some areas. This configuration may promote the retention of water adjacent to the slab edge and reduce effective surface drainage.

A CCTV inspection of the stormwater downpipe revealed standing water, confirming that the system is not freely draining. Cracking within the pipe was also observed. These conditions indicate that stormwater is likely not being effectively conveyed away from the structure and may instead be discharging into the surrounding soil.

The presence of a flooded and compromised stormwater system represents a significant source of ongoing moisture input into the subgrade. Over time, this can lead to soil softening, localised erosion or washout, and the development of voids beneath the slab.

Garden beds and landscaped areas were observed directly adjacent to the slab and structure, further contributing to moisture retention within the surrounding ground.

The site is located within the Gympie region, which is known for variable and moisture-sensitive subsurface conditions, further supporting the likelihood of subgrade-related influences.



Figures 5 and 6: Figures 5 and 6 illustrate separation and displacement along the slab edge, consistent with differential movement between the slab and adjacent ground. These conditions indicate subgrade instability or loss of support at the slab perimeter.

CCTV Inspection Photographs



Figures 7 and 8: Figures 7 and 8 illustrate the internal condition of the stormwater line. Figure 7 confirms the presence of standing water within the pipe, indicating inadequate drainage. Figure 8 shows hairline cracking along the pipe wall, which is likely to permit leakage into the surrounding subgrade and contribute to localised soil saturation.

GPR Data and Analysis

GPR analysis identified variable reinforcement cover, localised disruptions within the near-surface zone consistent with material variability and moisture influence, and deeper anomalies indicative of potential voiding or loss of support beneath the slab. Reflections consistent with structural elements such as footings were also observed.

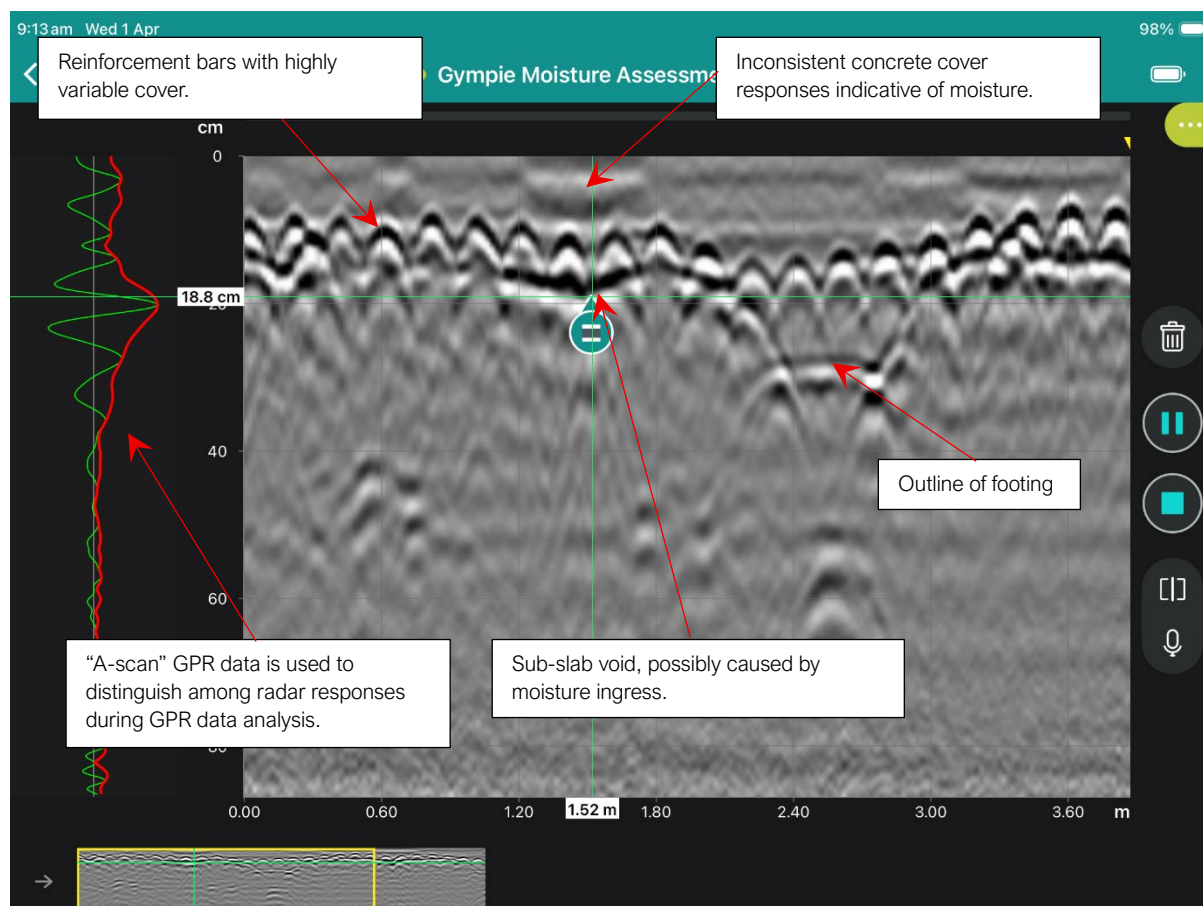


Figure 9: Figure 9 depicts representative GPR B-scan data collected across the slab. The upper portion of the scans shows reinforcement with highly variable cover, generally ranging between approximately 50 mm and 150 mm, indicating inconsistent placement or variable slab thickness.

Notably, the near-surface zone exhibits areas of disrupted, irregular signal response, characterised by reduced continuity and localised scattering. This behaviour is consistent with changes in material properties within the slab, which may be associated with moisture, variable concrete quality, or localised deterioration.

At greater depths, localised anomalies are observed as hyperbolic reflections and zones of signal disturbance beneath the slab. These features indicate subsurface irregularities and are consistent with potential voiding or loss of support within the subgrade.

Discussion and Cause Analysis

The observed conditions at the subject property indicate a moisture-driven deterioration mechanism affecting the garage slab, with evidence of both ongoing moisture ingress and subgrade instability.

The widespread efflorescence across the slab surface confirms that moisture is migrating through the concrete from below or from the slab perimeter. Efflorescence is not a source of moisture, but a visible indicator of ongoing moisture migration through the slab, and its presence across large areas of the slab indicates sustained moisture movement rather than isolated or incidental wetting.

The distribution of moisture, as confirmed through impedance testing, closely correlates with areas of visible efflorescence and cracking. Elevated moisture readings across the slab, particularly in the mid- to lower-region of the test grid, indicate that the slab is subject to persistent moisture exposure rather than intermittent surface wetting. This pattern is consistent with moisture originating from the subgrade or from external sources adjacent to the slab.

Ground-penetrating radar data identified localised anomalies beneath the slab, consistent with potential voiding or loss of support. These anomalies, when considered alongside the observed cracking patterns, suggest that the slab has experienced differential movement. The cracking is non-uniform and does not exhibit characteristics typical of shrinkage or reinforcement corrosion, instead indicating structural response to uneven support conditions.

External observations provide a clear mechanism for both moisture ingress and subgrade degradation. The stormwater downpipe was found to be flooded and cracked, indicating that stormwater is not being effectively discharged away from the structure. This condition is likely contributing to prolonged saturation of the surrounding soil.

In addition, the adjacent retaining wall was observed to be in a failed or failing condition, suggesting long-term soil saturation and lateral ground instability. The combination of ineffective drainage and retaining wall deterioration indicates that the subgrade conditions on the left side of the dwelling are likely compromised.

The presence of cracking in the external driveway and surrounding hardstand areas further supports the conclusion that ground movement is occurring at a broader site level and is not isolated to the garage slab.

The effectiveness of prior epoxy crack repairs was limited, with no observed reduction in moisture-related symptoms. This indicates that the cracks themselves are not the source of moisture ingress but rather serve as pathways for moisture to move through the slab. As such, surface-level remediation alone is insufficient to address the underlying issue.

Based on the available evidence, the most probable cause of the observed conditions is ongoing subgrade saturation due to ineffective stormwater management and external moisture sources, resulting in:

- Sustained moisture transmission through the slab, and
- Localised softening or erosion of the supporting soils beneath the slab

This combination has likely led to differential settlement, manifesting as cracking and allowing further moisture ingress through the slab.

Importantly, there is no evidence that the observed issues result from internal water sources or isolated slab defects. Rather, the conditions are consistent with external environmental and drainage-related factors influencing the performance of the slab and subgrade over time. While the findings are strongly supported by non-destructive testing and observed site conditions, confirmation of subsurface conditions would require targeted intrusive investigation.

Recommendations

Based on the findings of this investigation, remediation efforts should focus on addressing the underlying moisture ingress and subgrade conditions. Surface-level treatments alone are unlikely to provide a durable solution.

1. Stormwater System Rectification

A licensed drainage contractor should be engaged to conduct a detailed inspection and rectify the stormwater system.

The CCTV inspection confirmed that the downpipe is holding water and has cracked, indicating that the system is not functioning as intended. It is recommended that:

- The stormwater line is to be cleared, repaired, or replaced as required
- The system is confirmed to be free-flowing to a suitable discharge point
- Any damaged or leaking sections should be rectified to prevent the discharge of water into the surrounding subgrade

Restoring proper stormwater function is considered critical to reducing ongoing moisture loading adjacent to the slab.

2. External Drainage and Surface Water Management

External drainage conditions should be reviewed and improved to ensure that water is directed away from the structure.

This may include:

- regrading of surrounding surfaces to achieve a positive fall away from the slab
- installation of surface drainage measures where required
- reducing or eliminating areas where water may pond adjacent to the structure

Attention should be given to slab edge conditions and areas where external levels are close to or above the internal slab level.

3. Retaining Wall Assessment and Replacement

The existing timber retaining wall should be assessed by a suitably qualified contractor or engineer.

Given the observed deterioration and partial collapse, it is recommended that:

- The retaining structure should be repaired or replaced
- Appropriate drainage should be incorporated behind the retaining wall
- Measures be implemented to prevent long-term moisture retention within the retained soil

Failure to address the retaining wall condition is likely to result in continued subgrade saturation and instability.

4. Subgrade and Slab Support Assessment

A geotechnical or structural assessment is recommended to further evaluate the condition of the founding soils and slab support.

This may include:

- investigation of subgrade moisture conditions
- verification of potential voiding beneath the slab
- assessment of differential settlement across the slab



Where voiding or loss of support is confirmed, remedial measures such as pressure grouting or slab stabilisation may be required.

5. Targeted Intrusive Verification (If required)

When critical decisions regarding remediation or liability must be made, a targeted intrusive investigation may be undertaken to validate non-destructive findings.

This may include:

- localised coring to confirm slab thickness and condition
- inspection of sub-slab material and moisture conditions
- verification of voids identified through GPR

These works should be carefully planned to avoid damage to reinforcement or services.

6. Surface Remediation (Secondary to Source Control)

Surface-level repairs, including crack sealing, grinding, or coating application, should only be considered after the underlying moisture ingress has been addressed.

Previous attempts to seal cracks using epoxy have not prevented the recurrence of moisture-related symptoms, indicating that such measures are ineffective in isolation.

Any future surface treatment should be designed with consideration of residual moisture conditions and may require the use of breathable or moisture-tolerant systems.

Summary of Recommendations

The primary focus of remediation should be:

- Restoring effective stormwater drainage
- Reducing external moisture loading
- Addressing retaining wall failure
- Stabilising subgrade conditions where required

Without addressing these underlying factors, the slab is likely to continue exhibiting moisture ingress, efflorescence, and progressive deterioration.

These matters should be addressed at a site and infrastructure level, as remediation limited to the slab itself will not resolve the underlying cause of the observed condition.

Concluding Remarks

The investigation findings indicate that the moisture-related deterioration observed within the garage slab is not the result of isolated surface exposure or internal water sources but is instead consistent with ongoing moisture ingress associated with external drainage conditions and subgrade behaviour. The presence of widespread efflorescence, elevated moisture readings, slab cracking, and subsurface anomalies, when considered alongside the identified drainage deficiencies and surrounding ground conditions, supports the conclusion that the slab is being affected by sustained moisture loading from outside the slab system.

While the garage slab exhibits visible distress, the evidence suggests that the underlying cause is not confined to the slab itself. Rather, the observed condition reflects the influence of external factors, including impaired stormwater performance and moisture-affected ground conditions in the vicinity of the structure.

Accordingly, remediation efforts should focus on addressing these external and subgrade-related factors. Without rectification of the contributing drainage and ground conditions, moisture ingress and associated slab deterioration will likely persist, regardless of any surface-level repair works undertaken. The identified contributing factors, including stormwater system failure, external drainage conditions, and adjacent ground instability, are external to the slab itself and not attributable to isolated construction defects within it. The observed conditions are consistent with external environmental and infrastructure-related factors rather than isolated slab failure.



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