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Field Judgment and Structural Repair in RCC Crack Diagnosis: Integrating Expertise with Remedial Action

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Abstract: Crack diagnosis and repair decisions in RCC structures are often shaped by experienced engineers' field judgment rather than formal classifications alone. This study draws on diagnostic insights from 40 cracked buildings in Tamil Nadu and Karnataka, using a hybrid dataset that integrates empirical testing with interpretive interviews. The analysis explores how crack type, recurrence risk, and observed severity influence remedial strategies such as epoxy grouting, slab repair, and structural strengthening. Chi-square tests validate that crack type alone does not predict the need for structural reinforcement, while recurrence risk shows significant association with long-term repair proposals. The study affirms the diagnostic value of experiential logic in engineering decision-making and proposes a Decision Integration Matrix to guide responsive, evidence-based repair planning.

Keywords: RCC Cracks, Structural Strengthening, Engineer Judgment, Repair Strategies, Recurrence Risk, Hybrid Diagnosis.

I. INTRODUCTION

Diagnosing and responding to RCC cracking is both a technical and interpretive task. While structural codes distinguish between structural and non-structural cracks, experienced engineers in field settings often base repair decisions not merely on visual typology but on severity, recurrence, soil behaviour, and environmental exposure. Studies on engineering diagnosis have emphasized the growing importance of expert intuition in field-level decision-making (Wu et al. 2007; Garavaglia et al. 2018; Mishra et al. 2022). The limitations of rigid classification schemes have been noted in structural health monitoring literature, particularly in environments with high material and construction variability. This paper investigates how engineers integrate diagnostic cues to arrive at practical repair strategies that respond to contextual realities.

II. METHODOLOGY

This study analyses 40 field-documented RCC crack cases from Tamil Nadu and Karnataka. The dataset was developed through structured checklists, diagnostic interviews, and visual and non-destructive testing (NDT) records (Wu et al. 2007). The sample includes structures from varying soil contexts, environmental exposures, and structural configurations. Interviews were conducted with five senior engineers with a mean experience of 28 years, ensuring reliability and contextual depth (Mishra et al. 2022).
A hybrid methodology—combining empirical testing and expert interpretation—was applied in line with best practices in adaptive structural diagnostics (Garavaglia et al. 2018).The analysis integrates five core tables:

- Table 1: Engineer Profile
- Table 4: Testing and Integrity Status
- Table 7: Remedial Actions and Final Diagnosis
- Table 11: Crack Type × Structural Strengthening
- Table 12: Recurrence Risk × Long-Term Solution

Chi-square tests were employed to test the statistical significance of associations between diagnostic categories and corresponding repair interventions. A mixed-methods interpretive framework was adopted to synthesize empirical and experiential insight.

III. APPENDIX A: TABLES

Table 1: Engineer Profile

Designation	Count	Percentage
Structural & Repair Consultant	3	60.0%
L&T Engineers	2	40.0%
Average Years of Experience	28	—

Table 4: Testing and Integrity Status

Category	Frequency	Percentage
Test Conducted	32	80.0%
No Test Conducted	8	20.0%
Visual + NDT	32	80.0%
Visual Only	8	20.0%
Within Design Limit	35	87.5%
Not Within Design Limit	5	12.5%
Structurally Safe	33	82.5%
Moderate Risk	3	7.5%
Severe Risk	4	10.0%

Table 7: Remedial Actions and Final Diagnosis

Action Category	Frequency	Percentage
Epoxy Grouting / Resin Injection	20	50.0%
Slab/Beam Repair	5	12.5%
Demolish & reconstruct	5	12.5%
Crack Filling Only	10	25.0%
Soil-Related Diagnosis	18	45.0%
Structural Detailing Error	10	25.0%
Moisture/Leakage Intrusion	7	17.5%
External Force / Maintenance	5	12.5%

Table 11: Crack Type × Structural Strengthening

Crack Type	Strengthening (Yes)	No Strengthening
Structural	7 (77.8%)	24 (77.4%)
Non-Structural	2 (22.2%)	7 (22.6%)
Total	9	31
Chi-square	0.0002	p-value: 0.987

Crack Type	Strengthening (Yes)	No Strengthening
Cramér's V	0.002	

Table 12: Recurrence Risk × Long-Term Solution

Recurrence Risk	Long-Term Proposed	Not Proposed
Low	8 (50.0%)	19 (79.2%)
Medium	2 (12.5%)	3 (12.5%)
High	6 (37.5%)	2 (8.3%)
Total	16	24
Chi-square	6.39	p-value: 0.041
Cramér's V	0.40	

IV. RESULTS

A. *Engineer Profile and Interpretive Authority*

Table 1 indicates that 60% of respondents were independent consultants and 40% represented institutional or corporate infrastructure sectors. All had over 25 years of field experience. The high level of professional exposure suggests that diagnostic and remedial decisions were informed by deep contextual knowledge, extending beyond codified inspection protocols.

B. *Crack Type vs. Structural Strengthening*

Despite 90% of all cracks being classified as structural, only 22.5% of the buildings were recommended for structural strengthening. Table 11 indicates that the statistical relationship between crack type and strengthening recommendation is negligible (Chi-square = 0.0002, p = 0.987; Cramér's V = 0.002). This result confirms field observations that engineers assess a broader diagnostic field—including severity progression, soil-induced movement, and recurrence probability—before making repair decisions.

C. *Recurrence Risk and Long-Term Interventions*

Table 12 reveals that recurrence risk significantly influenced long-term remedial proposals. High-risk structures (20% of the sample) often required interventions such as slab repair, base reinforcement, or partial demolition. The association was statistically significant (Chi-square = 6.39, p = 0.041; Cramér's V = 0.40), reinforcing that field-based engineers respond more strongly to predictive markers of future failure than to static visual classifications.

D. *Repair Strategies by Diagnostic Judgment*

As detailed in Table 7, epoxy or resin injection was prescribed in 50% of cases, often in hairline or moderate structural cracks without severe recurrence. For cases showing structural displacement or joint deterioration, beam or slab strengthening was implemented (12.5%). Where severe recurrence or systemic risk was identified, demolition and targeted reconstruction was recommended (12.5%). Engineers emphasized diagnostic layering—evaluating not just crack width, but progression, material context, drainage history, and structural function.

V. DISCUSSION

The findings reaffirm that repair decisions in RCC cracking are not governed by typology alone but emerge from a layered synthesis of recurrence, risk assessment, and interpretive judgment. The statistically insignificant link between crack type and strengthening (Table 11) suggests that engineers privilege recurrence cues, structural system behaviour, and visual-spatial propagation.

This supports the construction of a Decision Integration Matrix that calibrates interventions based on three domains:

1) Severity and spread – localized or systemic
2) Recurrence Probability – based on soil, drainage, and repair history
3) Structural Role of Cracked Element – critical load path or non-load bearing

Such a matrix mirrors frameworks proposed in adaptive structural monitoring literature (Garavaglia et al. 2018; Mishra et al. 2022), where qualitative expertise is used to refine empirically driven models.

Moreover, engineer interviews revealed that decisions often depended on undocumented cues: crack noise, vibration effects, time of occurrence, or previous repair performance—confirming the role of tacit knowledge in structural care (Wu et al. 2007).

VI. CONCLUSION

Repair strategies in RCC cracking emerge not from linear rules but from interpretive synthesis—blending recurrence forecasting, severity appraisal, and contextual awareness. Engineers in the field exercise diagnostic maturity, weighing risk, cost, material fatigue, and environmental feedback. The study confirms that a Decision Integration Matrix may help engineers and agencies transition from reactive repairs to proactive, logic-driven care models, enhancing structural resilience in varied soil and design contexts.

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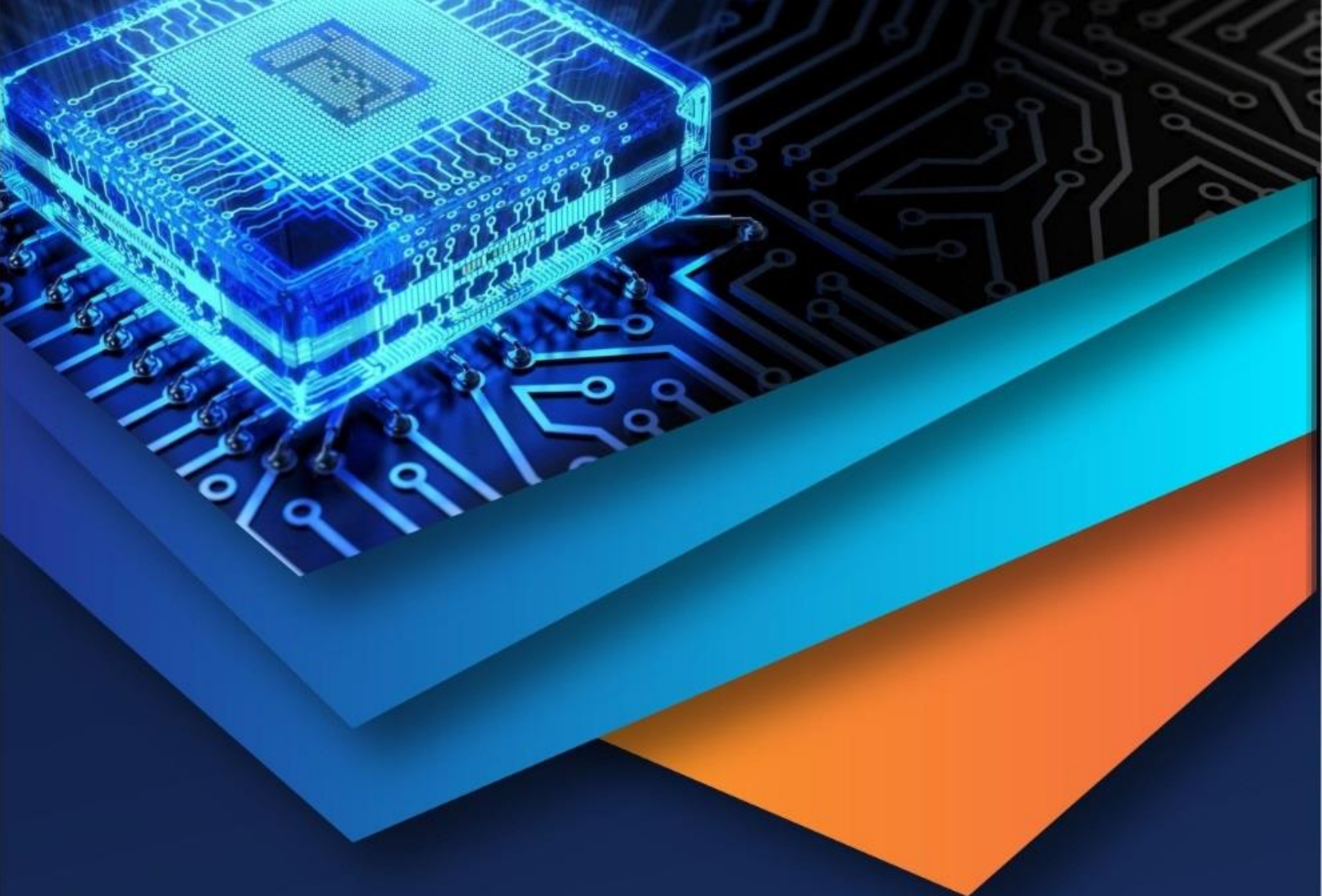

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