

INVESTIGATING THE STRUCTURAL ISSUES CAUSED BY TELECOMMUNICATION TOWERS CONSTRUCTED ON ROOFTOP SLABS

P. Shangari¹, H.G.H. Damruwan², K. Baskaran^{1*}

¹ Department of Civil Engineering, University of Moratuwa, Moratuwa, Sri Lanka

**Corresponding author: shangari.p.21@uom.lk*

Abstract

Rooftop installation of telecommunication towers on existing buildings has become a common strategy for expanding network coverage in dense urban areas of Sri Lanka. However, many existing structures were not originally designed to support the additional loads imposed by such installations, raising concerns regarding structural integrity and long-term durability. This study systematically investigates the structural and durability issues associated with rooftop telecommunication tower installations through field investigations across twelve sites, finite element modelling of a representative case study, and manual calculations per Eurocode standards. Field inspections revealed prevalent durability problems including water leakage, concrete spalling, and exposed reinforcement, though major structural failures were not observed. However, finite element analysis under ultimate limit state loading indicated that the host structure lacks adequate reserve capacity, with critical beams exhibiting insufficient flexural and shear reinforcement, meaning that visible condition alone is not a reliable indicator of ultimate safety. This research identifies systemic gaps in current installation practices and recommends amendments to strengthen structural verification, durability requirements, and regulatory enforcement for rooftop tower installations.

Keywords: Rooftop telecommunication towers, Structural assessment, Durability, Finite element analysis, Wind loading

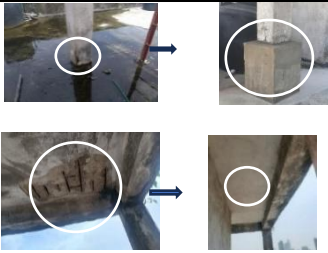
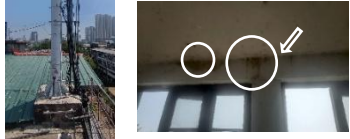
1. Introduction

Rooftop telecommunication tower installation has become a common solution to land scarcity in urban areas while providing building owners with supplementary income. However, many existing buildings were not originally designed to carry the additional static and dynamic loads imposed by these towers. Over time, these combined loads can cause excessive deflection, cracking, and overstressing of structural members, often leading to water leakage and accelerated material deterioration that may compromise building safety. Although the Telecommunication Regulatory Commission of Sri Lanka (TRCSL) established regulations in 2017 for the construction and maintenance of rooftop telecommunication towers, compliance with these requirements in practice remains inconsistent.

2. Methodology

The study combined qualitative field investigation with quantitative structural analysis, in three phases: literature and regulatory review, site investigation, and finite element modelling of a selected case study. Table 1 summarises four severe cases among the twelve site visits conducted. The four cases presented were purposively selected because they exhibited the most significant observable defects, specifically active structural cracking and water leakage issues.

Table 1: Summary of severe cases among the site visits conducted.

Site number	Building details and defects	Field observations	Site photos
Site 01	Storey – G+3 Tower height – 7 m	• Water ponding • Ageing of the structure • Cracks at the bottom of the column and concrete spalling were observed and rectified later.	
Site 02	Storey – G+4 Tower height – 7 m	• Water leaking issues and wet patches were identified inside the building, near the slab and beam connection.	
Site 03	Storey – G+4 Tower height – 9 m	• Longitudinal cracks were observed along the beam. • Wet patches were observed. • No waterproofing has been done on the roof slab.	
Site 04	Storey – G+2 Tower height – 24 m	• Severe water leakage and wet patches were observed at the slab soffit. • Waterproofing and appropriate draining of rainwater have not been provided.	

The summary of site visits indicated generally satisfactory structural performance across most locations. Most sites incorporated deliberate load transfer systems, such as separate base beam arrangements or thick concrete blocks, to effectively direct loads to host structure elements and prevent direct damage to the roof slab. Durability provisions, by contrast, were deficient at almost every site, including those with structurally sound arrangements. To critically evaluate structural integrity, a detailed analysis was conducted for a selected case study.

3. Analysis and Results

A detailed finite element analysis was conducted using SAP2000 for a 9 m monopole tower on a four-storey building. It was selected because it was the only accessible site exhibiting visible beam cracking beneath the tower together with water ingress and wet patches. The selection was purposive and is therefore treated as an indicative worst case rather than a generalisable sample. Dead and live loads were applied per Eurocode EN 1991. Wind loads were calculated following EN 1991-1-4:2005, using Section 7.9 for the circular pole and Section 7.6 for rectangular antennas. Eight wind directions were considered. Load combinations were formulated per Eurocode EN 1990, incorporating 33 ULS and 17 SLS combinations to assess structural integrity. The analysis results obtained are presented in Table 2.

Table 2: Results for modelling the case study.

Beam	Check	Condition	Required R/F (mm ²)	Provided R/F (mm ²)	Utilisation ratio = Demand / provided capacity	Status
Beam 01	Flexure (Sagging)	ULS	321	339	$321/339 = 0.947$ (<1)	Marginally adequate
Beam 01	Flexure (Hogging)	ULS	387	339	$387/339 = 1.142$ (>1)	Inadequate
Beam 02	Flexure (Sagging)	ULS	525	339	$525/339 = 1.549$ (>1)	Inadequate
Beam 02	Flexure (Sagging)	SLS	376	339	$376/339 = 1.109$ (>1)	Inadequate
Beam 01	Shear	ULS	R6 Mild Steel (275 MPa) @ 95 mm	Provided spacing is insufficient.	-	Shear links required
Beam 01	Shear	SLS	R6 Mild Steel (275 MPa) @ 130 mm	Spacing close to provided spacing of 120–150 mm	-	Sufficient

- Properties used - Beam 200×250 mm, concrete Grade 30 ($f_{ck} = 30$ MPa), steel S275 ($f_{yk} = 275$ MPa), 25 mm cover, 3T12 top and bottom bars, R6 links @ 120–150 mm.

4. Conclusion

- The provision of separate steel or concrete base beam systems effectively redirects tower loads to building columns, reducing stress concentrations in slabs and beams.
- The observed cracking in the case study was primarily attributable to durability deterioration and construction deficiencies rather than immediate structural overload, though the analysis confirms that the structure lacks adequate reserve capacity for future extreme loading events.
- The findings also highlight critical gaps in the current TRCSL regulatory framework. While guidelines mandate structural certification by a Chartered Civil Engineer, the analysis reveals ambiguity in practical compliance, as inadequate reinforcement was identified at several critical sections.
- The regulations do not adequately address long-term durability issues including waterproofing, drainage, and construction quality, which were widely observed across site visits and can progressively compromise host structures. To address these shortcomings, it is recommended that TRCSL guidelines be expanded to include mandatory maintenance reporting and detailed inspection requirements, enabling early detection of deterioration.

References

- [1] Abdullah, F. M. M., & Gunathilaka, A. M. L. N. (2025). Structural Effect on Columns of Existing Low-Rise Buildings due to Installation of Rooftop Towers - A Case Study. *Engineer Journal of the Institution of Engineers Sri Lanka*, 58(1), 171–181. <https://doi.org/10.4038/engineer.v58i1.7687>
- [2] Gunathilaka, A. M. L. N., Dayananda Associate (pvt) Ltd, Sri Lanka Telecom PLC, & Facility Management Division of Sri Lanka Telecom PLC. (n.d.). OPTIMIZED ROOF TOP TOWER DESIGN (By University of Moratuwa, Department of Civil Engineering, Sri Lanka, & Dayananda Associate (pvt) Ltd).
- [3] Telecommunication Regulatory Commission of Sri Lanka. (2017). *Guidelines on antenna structures*.

INVESTIGATING THE STRUCTURAL ISSUES CAUSED BY TELECOMMUNICATION TOWERS CONSTRUCTED ON ROOF TOP SLABS

Background



Different types of towers installed

1. Self supporting monopole tower
2. Self supporting lattice tower
3. Pole with supporting struts
4. Guyed mast

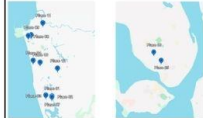
→ Expansion of network coverage ✓

→ Solution for land scarcity ✓

→ Income for building owners ✓

→ However, they compromise structural stability and durability performance of host structure.

Methodology



12 site visits done across Colombo and Batticaloa

- Cracks in beams
- Water leakages in beams and slabs
- No proper waterproof and water drainage provision.

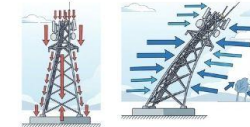
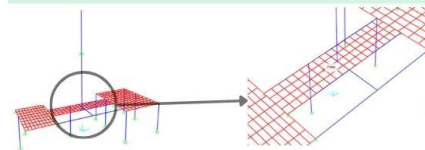


Finite element modelling was done for the selected case study to check the compliancy with the regulations in practice.

FE analysis

FE analysis done on SAP2000.

Eurocodes used for manual calculations



Static loading and Wind loading are applied

Analysis results shows that the host structure reinforcement is inadequate for ULS conditions

Conclusion

Adopt proper load transfer system

Durability issues are mostly observed and need to be considered before and after tower installation

Telecommunication Regulatory Commission Sri Lanka (TRCSL) guidelines should be adopted strictly and regular maintenance and inspection is required.

TRCSL guidelines should be amended to confirm the long term stability of host structures, provision of waterproofing and water drainage should be checked.