



# Introduction

The investment on building maintenance represents almost half of the total turnover of the construction industry and such reduction of resources has a direct effect on a nation's economy. Recent studies have shown that the main factors that lead to building operations and maintenance problems are due to faulty designs, faulty construction, financial factors and maintenance related defects. The lack of maintainability considerations during the design and construction stages lead to building defects which account for expenditures of billions of dollars throughout the building's lifecycle. More so, the potentially unsafe conditions of buildings (specifically on high rise building façades) can be detrimental to the lives and health of construction workers, and may even jeopardise public safety and surrounding properties if left unaddressed. Thus, to ensure the maintainability of buildings, the benchmark for quality must be established from the design stage itself in order to achieve quality design and construction, and maintenance best practices.

## **How to Use this Book**

The book is presented in six chapters highlighting the major building components: (1) basements, (2) wet areas, (3) façades, (4) roofs, (5) common areas and (6) M&E systems. Each chapter addresses the common defects and the corresponding design/construction/FM issues, with standards/guidelines/recommendations for the structural, architectural and service components of the building component, to be taken into account at the outset of the planning/design stage. Although the chapters are organised according to the normal physical order of a building (starting with the basement, followed by the wet areas, façades, roof, then common areas and M&E),

these chapters may be utilised individually to deal with specific problems, or may be combined for wide-ranging projects.

For example, the 'corrosion and spalling of concrete' in a basement is classified as a structural defect, highlighted with photographs taken from case studies, and the corresponding design, construction, and maintenance standards/guidelines to be considered at the outset of planning/design stage.

## Structural

Problem	Design	Construction	Maintenance
<b>Corrosion/spalling of concrete</b>  Spalled concrete and corrosion of exposed rebars  Extreme spalling and corrosion of basement	Comply with the design of concrete as per SS EN 1992-1-1:2008, SS EN 1992-1-2:2008 (2015), SS CP 65-1:1999. Specify admixtures (e.g. water reducing agent, pozzolanic products, pore refiner, etc.) to reduce permeability. Alternatively, for corrosion control in special areas with a high-risk of water penetration, an electrochemical treatment can be specified; a process where electrochemical drying of concrete occurs by passing a current through the reinforcement, similar in principle to cathodic protection (BS EN 1504-9:2008).	For the construction of basements, refer to the guidelines and provisions stipulated in SS CP 4:2003 (2012) (see also BS 8004:2015). Maintain water-cement ratio and the required aggregate grading during basement construction. <sup>1</sup> Verify aggregate quality in-compliance with ASTM C33/C33M-16e1. Use corrosion resistant bars and corrosion inhibitors. Apply proper vibration (compaction) and curing. Consider concrete sealing to avoid exposing the aggregate in concrete work (mitigate pitting, scaling, spalling, powdering, or chalking of concrete).	Conduct regular inspection in accordance to BS 8210:2012 to identify defects and ensure repair work is carried out before associated damage can occur. Testing of concrete via depth of carbonation to identify possible corrosion of rebar as per BS 1881-210:2013; or via phenolphthalein method as per BS EN 14630:2006. Repair and protect damaged concrete due to corrosion of reinforced steel as per BS EN 1504-9:2008.

The standards and guidelines specified should only be used as a reference. Supplementary sources and references are provided for further reading. A comprehensive index is provided to further assist the reader in locating a particular topic of interest within the book.