CHAPTER 1

INTRODUCTION

Staining or premature staining on building facades of new buildings has gained much attention in recent years. Resources required to tackle the problem represent a significant portion of the maintenance expenditure in the local construction industry.

Staining is defined as a mark or discolouration that is not easily removed. The build-up of stains on facades at a time before it is normal or expected can be termed as premature staining [1]. Factors that contribute to staining include material, exposure, design, colour, water absorptivity, dirt retention, texture and solubility. Stains form primarily from the surface flow of water (*runoff*) down the facade. Water brings along dirt particles that is retained on the facade material. When the water dries out, dirt particles that are not washed off manifest as stains [2–12]. Although traditional facade materials such as bricks, stones, concrete and wood are still in use, many non-porous and non-adsorptive materials such as glass, plastic and metal are gaining popularity. They are able to offer greater flexibility and functionality as well as better performances in aspects such as visual, thermal, spatial, acoustic, indoor air quality and building integrity. With new materials and more sophisticated facade designs, the provision of joints to effectively control rain runoff flow on the facade has to be re-looked since these materials are impermeable and runoff is generated almost immediately after a rainfall. New facade designs that give more consideration to runoff flow needs to be advocated. Buildings need to be designed to be more maintainable so that resources used on cleaning and maintenance work may be minimised [13–16]. The inclusion of certain architectural design features may cause retention of dirt and the flow of runoff to be uneven and uncontrolled, resulting in stains.

This book discusses the problems associated with staining from the following aspects:

- Environmental
- Material
- Design
- Maintenance

In Chapter 2, the significance of environmental conditions which a building facade is exposed to in relation to staining is discussed. Environmental conditions discussed include the effect of rain, wind, sunlight and pollutants.

Chapter 3 discusses the susceptibility of a material to staining from the perspective of the material characteristics including permeability, water absorption, surface texture, colour, chemical and biological resistance.

The design aspects are discussed in Chapter 4. The rain runoff flow pattern over some main facade design features is illustrated. The relationship between runoff flow pattern and staining patterns of four main design features namely, ledges, joints misalignment, protruding fixtures and louver units is elaborated. The importance of a combined effort from the design team to use stain-free designs, the construction team to ensure good workmanship, and the maintenance team to implement optimum maintenance strategy is highlighted.

Chapter 5 discusses the whole life performance of a facade in relation to maintenance aspects. Maintainability issues including cleaning, repair and replacement are evaluated. The various facade access systems for tall buildings are illustrated.

References

[1] P. Parnham, Prevention of Premature Staining of New Buildings, *E. & F.N. Spon*, London, 1997.

[2] L. Addleson and C. Rice, *Performance of Materials of Buildings*, Butterworth-Heinemann, Oxford, 1994.

[3] O. Beijer, *Weathering on External Walls of Concrete*, Swedish Concrete Research Council, Swedish Cement and Concrete Research Institute, Stockholm, 1980

[4] C. Briffett, The Performance of External Wall System in Tropical Climates, *Energy and Buildings*, Netherlands, 1990.

[5] C. Briffett, "External finishes — Case studies on problems and solutions", Building Protection Conference, Proceedings of *Inter-Faculty Conference on Protection of Buildings from the External Environment*, Paper 2, 1987

[6] C. Hall, "Absorption and shedding of rain by building surfaces", *Building & Environment* Vol. 17, 257–262, 1982.

[7] R. Cooper, "Factors affecting the production of surface runoff from wind-driven rain. *RILEM International Symposium*, Rotterdam del. 1.1.2, 1974.

[8] L. G. W. Verhoef, *Soiling and Cleaning of Building Facades*, Report of the Technical Committee 62 SCF, RILEM, Chapman and Hall, London, 1988.

[9] M. B. Ullah, "Analysis of rain and wind for building design", *National University of Singapore Seminar on Wind & Rain Penetration in Buildings*, 1994.

[10] M. C. Baker, "Rain deposit, water migration and dirt markings on buildings", *RILEM/ ASTM/ CIB Synposium on Evaluation of the Performance of External Vertical Surfaces of Buildings*, pp. 57–66, 1977.

[11] H. P. Teo and P. Ng, "External cladding defects in Singapore" in *Southeast Asia Building*, March, 1992.

[12] W. H. Ransom, *Building Failures: Diagnostics and Avoidance*, E. & F.N. Spon, London, 1987.

[13] M. Y. L. Chew, C. W. Wong and L. H. Kang, *Building Facades: A Guide to Common Defects in Tropical Climates*, World Scientific Publishing, Singapore, 1999.

[14] M. Y. L. Chew, "Efficient maintenance: Overcoming building defects and ensuring durability," *Conference on Building Safety*, The Asia Business Forum, Kuala Lumpur, 4 & 5 April 1994.

[15] E. B. Feldman, *Building Design for Maintainability*, McGraw-Hill, New York, 1975.

[16] N. G. Marsh, "The effect of design on maintenance", *Development in Building Maintenance — I*, Applied Science Publications Ltd., New York, 1979.