Department of Building, School of Design and Environment,
National University of Singapore

RESEARCH BRIEF 2004/010

# Life Cycle Costing for Façade Maintenance

## OBJECTIVE

The objective of this research project is to develop a quantitative model for effective evaluation, monitoring and management of the costs incurred for efficient maintenance of facades on external wall surfaces and provide guidance on the selection of types of plaster and paint for external wall surfaces.

## RESEARCH METHOD

The research project involved several steps. It started with a review of the different type of maintenance programmes, the requirements of the Singapore Standards for paint to be used externally, the different types of defects and the factors affecting the service life of the external paintwork. Possible attributes affecting and influencing the durability and service life of paintwork were identified, and five factors emerged: weather/macro environment, material composition of paint used, degree of workmanship, building characteristics/attributes and environmental pollution.

Interviews with town councils were conducted to find out about their commonly used façade maintenance programmes. Visual surveys were conducted in order to collect information on defects that appeared on the external finishes (paint and plaster) of public housing blocks (HDB flats). The collected data was organised into a software program to facilitate processing and easy use in the model development phase.

The visual surveys provided information about the occurrence of various defects on the external finish and the influence of the factors pertaining to the environment and building attributes. Since they were based on visual observation and judgement, it is not possible for these surveys to capture information on the influence of the material composition of the paint that was used and its quality or on the expected degree of workmanship during the last painting/ repainting work. Hence in order to account for these factors in the understanding of the service life of the external finish, interviews with paint manufacturers were conducted.

The visual surveys data was used in the development of the 'Defect Index Models' for the various paint and plaster defects; these models, in turn, helped to establish the timing and extent of spread of the defects and therefore served as the cornerstone for the development of the life-cycle cost-based model for façade maintenance.

## SURVEY

The population size for visual surveys for this study consists of all the HDB apartment blocks in Singapore. These apartment blocks island wide have been placed under the control of 16 town councils. Due to a large variation in the number of blocks in each age group, disproportionate stratified sampling was adopted to cover all the possible ranges of age groups so as to ensure the data collected in the surveys are accurate. 1754 HDB apartment blocks from 16 town councils were surveyed. The property maintenance managers of these town councils as well as the HDB-recommended paint manufacturers were interviewed.

## FINDING 1: LCC FRAMEWORK

The finding is that currently in the Singapore public housing context, the most commonly used façade maintenance programmes are a) *routine maintenance* and b) *corrective maintenance* or *reactive maintenance*. The use of these two approaches can entail higher maintenance costs. Hence it is necessary to develop a suitable maintenance strategy that avoids excessive maintenance costs and cuts

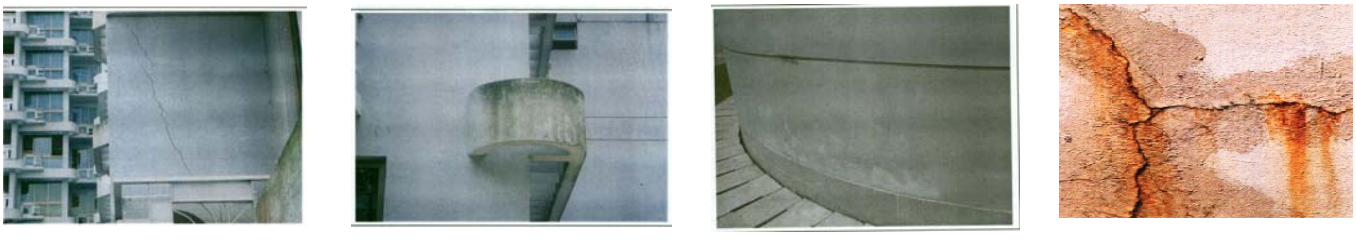

*Figure 1. Common defects on external wall surfaces – (from left) cracking, mould growth, efflorescence and rust staining.*

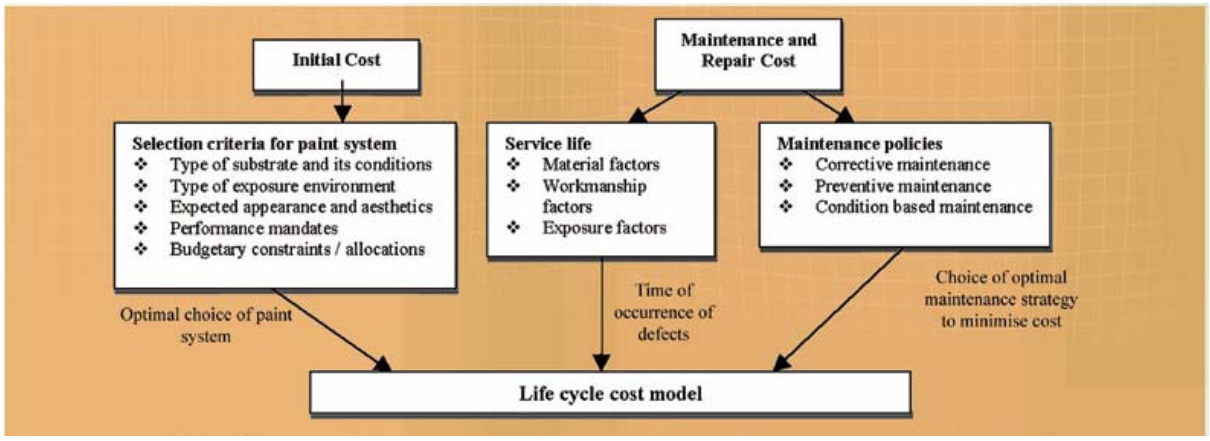


*Figure 2. Skeletal framework showing a life-cycle cost model for paint system for external wall surfaces.*

down on unnecessary maintenance. This can only be achieved through the optimal choice of paint system and optimal choice of maintenance strategy to minimise cost using the life-cycle cost model framework as shown in Figure 2.

## FINDING 2: DEFECT INDEX MODELS AND LCC MODEL

Based on the above framework, the Defect Index Models and LCC Model were designed (Figure 3).

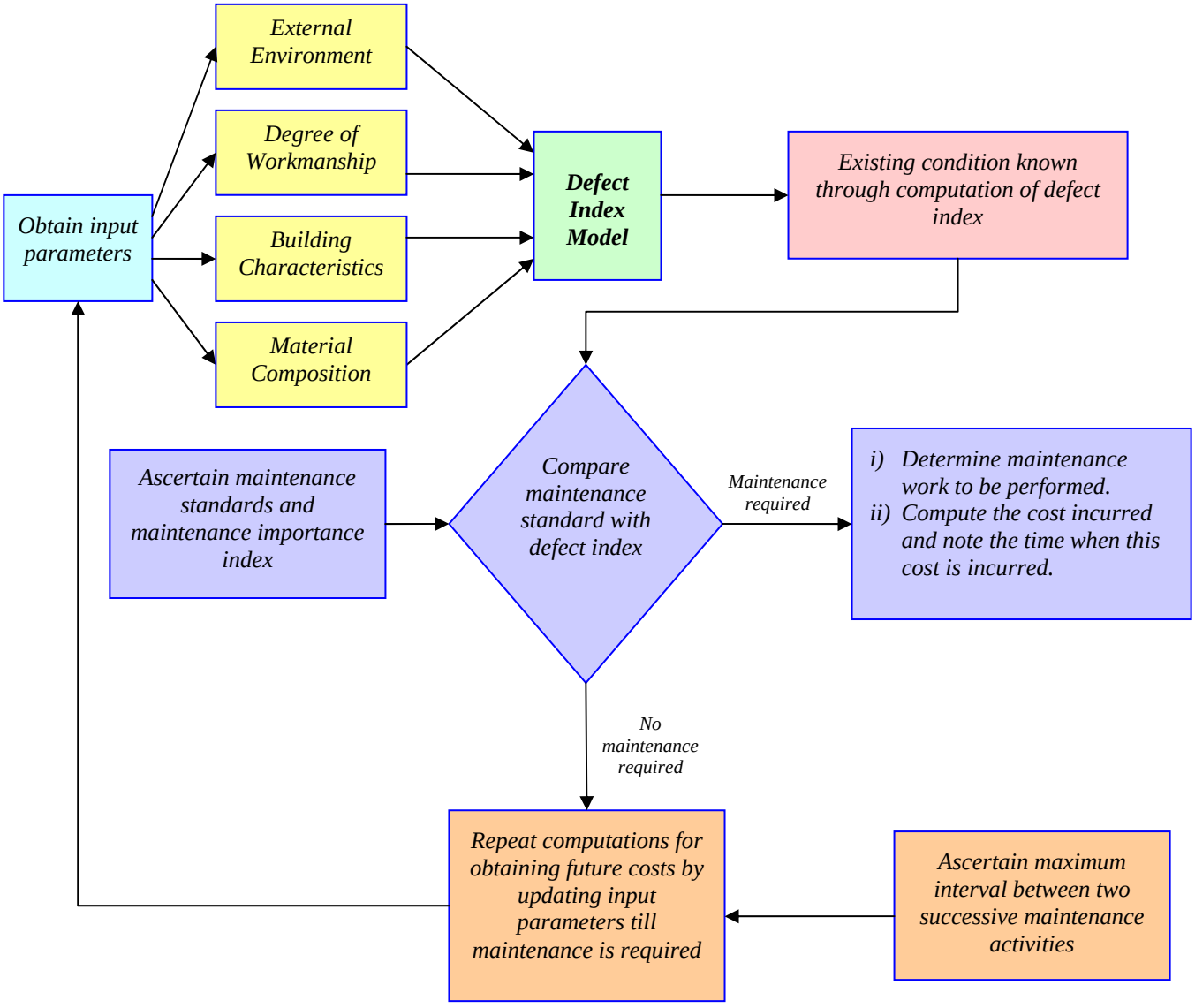


*Figure 3. Flow diagram for Defect Index Model and LCC Model.*

The Defect Index Models can be used to systematically codify defects and facilitate statistical analyses, and it had been incorporated into the Life Cycle Costing for Façade Maintenance Model to increase the breadth and depth of the LCC Model. The main finding is that owing to the vagaries of the different influencing factors, especially the external environment, it is not possible to achieve complete accuracy in the prediction of defects using models such as the proposed Defect Index Models. Hence the onset and occurrence of defects at an unexpected time must be appropriately dealt with by suitable maintenance action.

In consequence of a multitude of factors, a sudden or unexpected onset of a defect affecting the paint and/or the plaster is thus very much possible; maintenance work to address such occurrences comes under the realm of corrective/reactive maintenance. This thus brings into focus the effectiveness of preventive maintenance vis-à-vis corrective/reactive maintenance and the extent to which maintenance work should be based on prediction and prior planning. Consequently it is necessary to provide for sufficient allocations in the maintenance budget for such unscheduled maintenance activities. Thus although the use of a life-cycle cost-based approach would ideally pair up with the concept of preventive maintenance, it is necessary to accommodate the possibility of corrective/reactive maintenance to take care of unexpected occurrences of defects in the paint and plaster layers.

The inference of this finding is that a well-executed maintenance programme provides for an effective way to stretch maintenance budgets as far as possible without compromising on performance. Specifically, that an efficient and well-planned maintenance programme provides for an effective exercising of controls on the budget estimates in order to smoothen out the ebb and flow of maintenance costs. The ultimate aim is to achieve value for money with the budget expended on maintenance.

## CONCLUSION

The Defect Index Models and LCC Model had been successfully developed and tested. To facilitate the implementation of these models, the user-friendly electronic version of Defect Index Models and LCC Model software and a good maintenance practices for plastered and painted facades manual have also been developed. The LCC Model and its accompanying set of defect index models can be used to assist town councils to prepare the budgets for maintenance and repair work. It can also help the town councils to select a better value for money paintwork system for the façade of public housing sectors.

## CONTACT DETAILS

**Dr TEO Ai Lin, Evelyn and**
**Assoc Prof Michael CHEW**
Department of Building
School of Design and Environment
National University of Singapore
4 Architecture Drive
Singapore 117566
Tel: (65) 6874 1008; Fax: (65) 6775 5502
E-mail: bdgteoal@nus.edu.sg and
bdgchewm@nus.edu.sg