Building repair and rehabilitation in a global paradigm of climate change, resource depletion and an increasing demand for building stock

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Abstract. The current industry processes to address the repair and rehabilitation of buildings are inadequate to provide an effective extension of serviceable life. This often leads to premature demolition. Developed in practice, an improved adaptation of the conventional new-build staged methodology is proposed to give buildings a second life which, if led correctly by the concrete repair specialist, can extend the life and keep the embodied CO_2 stored in the building for another generation.

1 Introduction

The successful repair and rehabilitation of concrete structures is to extend service life and to avoid demolition. This is imperative if we are to achieve zero atmospheric carbon by 2050 and to reduce resource depletion. Currently a 30 year old building embodies a similar amount of CO2 as its operational energy if fossil fuel-based. Retrofitting existing buildings to reduce operational energy will become easier with new technologies. Therefore repairing and rehabilitating degrading buildings to avoid demolition and keep embodied CO2 is critical for planetary health.

Too many buildings are being demolished, mainly due to poor assessments. This paper proposes an alternate assessment-design-repair methodology to the current approach for buildings.

2 The current approach

In civil engineering structures the concrete is generally exposed and concrete repair specialists are consulted as defects manifest. In buildings the structure is usually hidden by finishes with defects manifesting when degradation is advanced, the building condition curve taking a downward turn (Figure 1). This is prevalent in many concrete frame buildings designed and built in the 60s and 70s when durability was not understood.

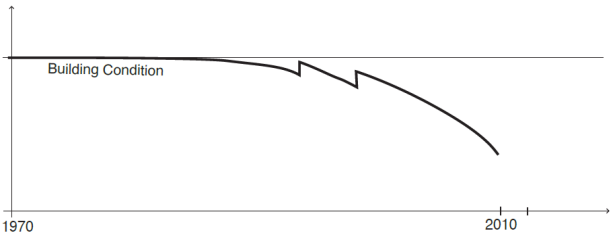

Fig. 1. Senator Park, Cape Town - a high rise apartment block

In degrading commercial buildings rental returns drop. Fewer funds become available for repair with further drops in rent. This leads to further degradation and an erosion of the building value (Figure 2). Demolition becomes an option.

Demolition of a listed building requires Heritage approval and cannot be demolished unless an engineer determines that it is not structurally safe nor capable of being made safe. The demolition of unlisted buildings is the owner's decision. Decisions are often made without sound engineering advice from concrete building specialists, as the process to make such building assessments is largely absent in South Africa.

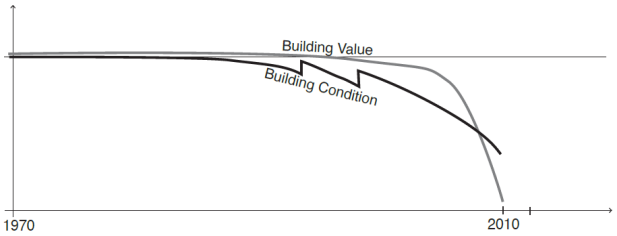

Fig. 2. Senator Park, Cape Town – the building value dropped as degradation manifested

In contrast, the norm for new civil engineering and building projects is a rigorous design process. The appointed Principal Consultant ("PC"), assisted by specialist consultants, takes the project through 4 sequential Stages of Design [1] (Figure 3). Buildings require regulatory approval. If viable after the first two stages (brief/inception and concept design/ viability) then the team 'builds' the project on paper during the next two stages (design development/ regulatory approval and specifications/pricing documentation). The appointed Principal Contractor is assisted by specialist sub-contractors. In civil engineering structures the PC is an engineer, in buildings an architect. Determining feasibility and

ensuring viability makes the Principal Consultant the project investment advisor.

The methodology for the assessment and repair and rehabilitation for ageing concrete buildings with advanced deterioration is relatively less well applied in the building industry, if at all. Such defects are incorrectly considered to be normal wear and tear with owners employing decorating contractors who double as concrete repair 'consultants'. Sometimes a non-specialist engineer is consulted who, after a visual inspection, incorrectly proposes demolition or provides a general repair specification extracted from product specifications. Pricing is similarly generic with the expected under-estimations. A proper condition assessment is only conducted during construction, the process similar to a geotechnical investigation being undertaken once the foundations have been dug, usually providing similar unwelcome surprises.

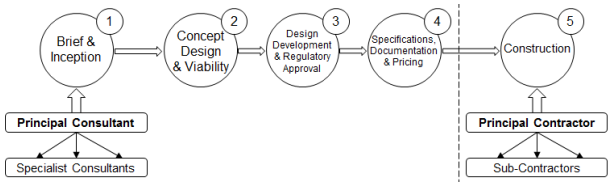

Fig. 3. The conventional 4 stages of design and construction

Thus the extent of the concrete degradation is revealed during construction, and in cases is so complex that work has to be aborted. Demolition becomes a resigned option. At best concrete repair specialists are consulted to rectify the situation; the parties not initially aware that the assessment of the residual structural capacity of the degraded RC structure is a highly specialized field. The client bears the cost and time overruns.

However the specialist assessment and repair of such advanced deterioration in ageing RC structures is not part of regular maintenance or normal wear and tear as contemplated by the National Building Regulations ("NBR") [2] [3]. An application to the Local Authority ("LA") is required for structural repairs under the direction of an appointed competent person ("CP") who is '*qualified by virtue of his education, training, experience and contextual knowledge to make a determination regarding the performance of a building or part thereof …*' [4]. This is a structural engineer (or two) who is a concrete repair and rehabilitation specialist. Without this appointment the owner fails to comply [5] [6], with neither the concrete defects adequately analysed nor the root cause of the problem and risks properly identified. Many ageing buildings are unnecessarily demolished or repairs not properly strategized.

3 An improved approach

A staged methodology developed and successfully tested in practice seeks to address the above shortfalls (Figure 4) to give the best chance to avoid demolition and to give the building a valuable working life.

Four essential adaptations are made to the conventional 4 Stage design methodology:

1. As per the NBR, the Stage 1 appointed competent person (Principal Consultant) is a RC repair specialist engineer [6]. Assisted by specialist consultants (engineers/architect/QS) they advise on the building asset and LA approvals. The historical plans, reports and maintenance records are researched and measured drawings prepared.
2. A RC repair specialist contractor (with abseiling specialists) is appointed during Stage 1 who makes the works safe and exposes and records as many of RC defects as possible to allow for a thorough Stage 2 condition assessment. As-built details of the defects are drawn. The defects are classified into types and mapped onto the plans. Site and laboratory testing enables a condition analysis. If repairs are feasible then preliminary repair strategies and specifications are developed with the specialist contractor for each defect type. Costs are estimated.

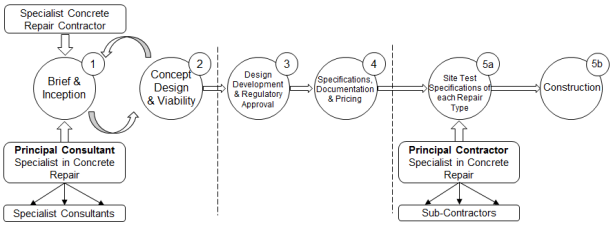

Fig. 4. Proposed adaptation to the conventional stages of design and construction

3. If repairs are viable the Brief is revised to enable a 2nd Stage 2 condition assessment and compliance check but of all the building systems including *inter alia* services, M&E, finishes, structures, openings, water proofing and energy efficiency. Costs are revised.
4. Outdated buildings may require an upgrade or repurposing to make the rehabilitation viable. If so, then Stage 1 and 2 are repeated until a feasible and viable solution is developed. An informed brief is thus developed with the client. An application is made to the LA with the repair and upgrade plans.

Two essential changes are made to construction Stage 5.

1. A new pre-contract Stage 5a is added where each defect type is repaired. This is to test the

specifications and to agree on the procedures, measurement and certification of each type. The recorded testing is the bench mark for quality control.

2. During Stage 5, each defect (with co-ordinates) receives a quality control and claims record sheet with 4 photographs: before opening up, remedial work and closing-up, and after closing-up before painting. The engineer is called to inspect unique defects. These records are provided to the client for maintenance.

Case studies of two developments where demolition was averted by the author, one heritage and one 1970s high rise apartment where the methodology was applied to upgrade the building (Figure 5) are presented in the key-note address.

References

1. ECSA BOARD NOTICE No 138 GG 39480 Published 4 Dec 2015
2. National Building Regulation, A15 (2): Maintenance and operation
3. National Building Regulation, A1 (4): Application
4. National Building Regulation: Definitions
5. National Building Regulation and Building Standards Act: Section 4
6. National Building Regulation, A19 (1): Appointment of persons responsible for design, inspection and assessment duties.