

CONCEPTUAL STUDY ON CONSTRUCTION DEFECTS AND ITS SOLUTION

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Abstract: In the construction industry, construction defects and failures can occur during the design and construction phases of a project, or after a structure is substantially complete. However, while a design professional is responsible to produce complete, accurate and well-coordinated design and construction documents that are substantially free of defects; and a contractor is required to adhere to the design and construction documents, nothing built is ever perfect nor does the law require a perfect design. Furthermore, all buildings have an expected lifespan and even the structures of the ancient world will erode into a mound of sand given enough time. The eventual failure of a structure is an expected result rather than a manifestation of a construction defect. The question becomes what is a construction defect; how do defects arise; and how can defects be identified and managed?

Construction defects can arise in a multitude of ways. Construction defects can be visible to the eye or concealed deep within the structure. Regardless of the methods and materials used, all structures can fail prior to the end of their useful life and such failure can result in damage to a person and/or to the structure. The premature failure of a component part of a structure that causes damage to a person or property can be considered a construction defect.

Keywords: Construction Defects, Structural Cracks, Prevention measures, Causes of Cracks.

I. INTRODUCTION

Construction defects that directly affect the performance of a structure can be the result of defective design or construction; defects that allow moisture intrusion into the structure; and defects that will render the building structurally unsound. In general, examples of these defects are: A design that fails to meet the Professional Standard of Care. A design that was not prepared in accordance with the applicable building codes. The failure of the contractor to execute the work in accordance with the plans and specifications. The failure of the contractor to execute the work in accordance with the acceptable standards of workmanship in the construction industry. The improper installation of systems, equipment or materials that are of a lesser quality than required by the plans and specifications.

A construction defect is generally defined as a defect or deficiency in the design, the construction, and/or in the materials or systems used on a project that may not be readily observable and results in a building, structure or component that is not suitable

for the purpose intended. Therefore, the term “construction defect” is broader than just defective construction. The term “construction defect” includes both design and construction defects that result in financial harm to the owner.

II. CAUSES OF CONSTRUCTION DEFECTS

Design defects have become prevalent as a result of the trend to abandon the traditional design approach where the architect would utilize established architectural standards and details for the construction of a building that were similar and consistent, i.e. “tried and true.” The introduction of computer-aided design (“CAD”) with its dependence on stock details, coupled with the rapidly evolving new building materials and systems has had a dramatic impact on the design and construction detailing of new buildings and has greatly increased the potential for defective design. The new materials and systems, many of them untested over time, have limited applications and in many cases are not ideally suited for a particular application, building type and/or geographic location. Architects, in lieu of employing time-tested materials and assemblies, rely on the information, literature and details supplied by the manufacture for the new materials and/or assemblies without a full understanding these limitations and the proper application of the new materials and systems. The vast array of new materials and systems has played a critical role in the increase in design defects claims. Architects also have tended to reduce the level of details they provide in the design and construction documents in a conscious and misguided effort to leave the construction detailing to the imagination and creativity of the contractor. This lack of adequate detailing may also be due to the lack of experience and understanding by the architect of the basics of a particular assembly and/or material. The incidence of construction defects has increased due to a fundamental change in the role of the contractor. The “Master Builder” has become the master broker whose goal of low initial cost and higher profits has overridden the goal of providing a defect-free product. Speed and profit have become the contractor’s primary considerations and goals.

III. TYPES OF CONSTRUCTION DEFECTS

Table 1: Common building defects and their symptoms

Common Defects	Symptoms/Phenomenon	Possible Causes
Defective concrete spalling or loose plaster in ceilings	Surface with Water/rust staining, water leakage Patterned cracking Bulging, Falling off of concrete patches with reinforcement exposed, often rusty Falling off of plaster	Defective concrete as a result of ageing is commonly found in old buildings. Persistent water leakage may affect the steel reinforcement. Weak concrete caused by the use of salty water in concrete mix, or overloading are also common causes in spalling
Water seepage from External wall, window, roof, or from ceiling	Water staining Peeling off of paper Water dripping Growth of fungus Defective concrete, tiles	External water seepage could be due to a variety of reasons including cracks on external wall, honey comb concrete, defective sealant at window, defective water proofing

	Rust staining	membrane at roof, defective external water and drainage pipes, etc
Structural cracks in Walls	Cracks that penetrate through finishes into the concrete or bricks Long, continuous cracks across width of wall Diagonal cracks at corners of window or door Cracks with rust	Structural cracks may be caused by many factors, e.g. excessive movement of the building structure, unwanted ground settlement, serious overloading, weaknesses caused by corrosion/deterioration of materials, or damage by accidents, or poor design/ construction, etc. Detailed investigation must be carried out to identify the cause(s) which must be removed or rectified before the cracks are repaired.
Structural cracks in Columns & beams	Cracks that penetrate through finishes Down to the concrete or bricks.	Structural cracks may be caused by many factors, e.g. excessive movement of the building structure, unwanted ground settlement, serious overloading, weaknesses caused by corrosion/deterioration of materials, or damage by accidents, or poor design/ construction, etc.
Non-structural cracks (usually in plaster or other finishes with cement sand rendering as base)	Hairline cracks Multi-directional cracks (shrinkage cracks) Cracks between panel walls and structural elements e.g. brick wall and beams/columns	Cosmetic shrinkage cracks in plaster or other forms of finishes will affect the appearance only and do not pose any safety concern. They are small hairline cracks developed within the finishes layer not penetrating down to the reinforced concrete structure
Defective external wall Finishes/mosaic tiles/ceramic tiles/stone cladding/curtain wall	De bonding of finishes/tiles from wall structure resulting in “hollow sound” when tapped with a hammer Cracking of wall surfaces Bulging with hollow base Falling off Cracks Loosening of parts.	The defects could be due to ageing, structural movements, defective workmanship during installation, thermal movement, defective or missing expansion joints, damage by external factors(e.g. falling objects during typhoon), ingress of water into the gap between the finishes or tiles and the structure, etc.

Table 2: Causes and symptoms of common defects in building services

System	Symptoms/Phenomenon	Possible Causes
water supply	<p>Insufficient water pressure or flows</p> <p>Brownish water</p> <p>Stoppage of supply</p> <p>Water seepage</p> <p>Unclean water, algae growth, dirt and deposit</p> <p>Sudden rise in consumption</p> <p>Noisy water pumps, noisy water inlets</p>	<p>Blockage or leakage of components of the supply system such as pipes or valves</p> <p>Rusty pipes or dirty supply tanks</p> <p>Pump failure, breakage of supply pipe</p> <p>Defective water tanks, pipes or valves</p> <p>Defective or missing water tank cover</p> <p>Leakage in the system after water meters</p> <p>Defective water pumps, undue water pressure</p>
Electricity supply	<p>Stoppage of supply/ system breakdown</p> <p>Sudden or frequent fuse or circuit breaker cut off leading to stoppage</p> <p>Heating of switches & wires</p> <p>Sudden stoppage and larger power consumption</p> <p>Electric sparks or shocks, electrocution</p>	<p>Failure of fuse or circuit breaker</p> <p>Earth leakage, overloading</p> <p>Overloading</p> <p>Uneven distribution of phases</p> <p>Inadequate earth bonding</p>
Fire services	<p>Alarm not working (when tested), false alarm or warning lights on signal panels</p> <p>Portable equipment lost or misplaced, glass panels of alarm switch box-broken</p> <p>Non-functioning of equipment</p>	<p>Alarm wiring defect, short circuit</p> <p>Inadequate protection or poor management</p> <p>Inadequate maintenance or servicing</p>
Lift and escalator	<p>Stoppage, excessive noise during operation, indicator lamps off, unstable lifting, malfunction of buttons and indicator lamps</p> <p>Occasional overrun</p> <p>Doors not closing properly</p> <p>Defective mechanical parts, frequent stoppage, alarm signals</p>	<p>Ageing of parts, mechanical failure</p> <p>Landing misalignment</p> <p>Parts ageing, mechanical failure, rubbish obstructing operation</p> <p>Inadequate servicing</p>

Air conditioning/Heating	Not cool enough, not warm enough Noisy, no air movement Engines sound normal but no air movement Noisy blowers or propellers movement Poor indoor air quality Dripping and substandard output of cool or warm air Noisy blowers or propellers movement	Poor efficiency, leakage of refrigerant dust and dirt at heat transmission fins Loosen parts, blowers or propellers breakage Dust screens blocked, air ducts and grilles needs cleaning Misalignment of motor shafts Insufficient fresh air intake, mal-function of intake air filter Insulation failure
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Table 3: Water leakages and their causes

Location of leakage or seepage	Possible causes
Underside of roofs (such as flat roof, podium roofs) and bottom of light wells	Damage or deterioration of water proofing layer Leakage at access doors or top hatch doors Deterioration of corrugated steel roofing materials and joints Defective enclosure for water tanks Cracks of parapet walls affecting the water proofing membrane Inadequate protection/improper installation of sleeve around openings through roof slab Excessive movements of construction joints
Ceiling with internal areas above	Leakage from bathroom or kitchen above usually caused by seepage from fitments, bathtubs, shower trays, buried pipes or drains due to improper construction of joints, installation of sealants or occurrence of cracks Waterproof cement rendering under neath floor tiles for the floor above not installed/specified or such waterproofing features damaged by installation of sockets or conduits Mal-function of waterproofing in nearby external features such as balconies or external walls above
Wall	Water penetration through external wall defects such as cracks, joints, honeycombs, spalling, weak points, holes, punctures, leftovers of debris, and movement of external wall components Water penetration through defective external wall finishes such as loosened mosaic tiles, cracked ceramic tiles & paint surface; through poor cladding or curtain walls constructions; or weaknesses in water-resisting components Water leakage through party walls between units of pre-fabricated elements, or between buildings
Floor	Seepage from defective pipe works or sanitary fitments Temporary floods and overflows Defective bathroom fitments such as bathtubs, shower trays or hand wash basins, or the improper installations of pipe works or necessary

	sealants.
window	Improper fillings around frames Deformation of frame and sashes, defective gasket, sealant or putty for window glass setting or frames Air conditioning box or platform tilting inwards Insufficient sealant around air conditioning units
Basement	Inadequate or damaged waterproofing tanking Deterioration of water stops at construction/movement joints
Buried or underground drains or pipes	Seepage through defective joints or pipes caused by poor installation or differential movements/settlements, movement of building structures or ground or water table Corrosion of pipes at junctions with floors or walls Invasion of water into conduits and distribute throughout the network Blockage leading to excessive pressure built up Attack by rodents or roots of plants
Exposed (or in pipe ducts) supply pipes or drains	Inadequacy in design of drains such as insufficient diameter of drains, bends being too sharp, etc. Blockage of drains by rubbish/sand collected in the system especially in bends or traps Insufficient number or deterioration of brackets leading to hammering and breakage of supply pipes Blockage of open joints such as hoppers of down pipes by plants rubbish Unauthorized additions overloading the drainage system

IV. COMMON DEFECTS IN BUILDING DUE TO NEGLIGENCE

These can be classified based on its position and its nature of construction as under:

- i. Improper layout
- ii. Improper orientation of buildings, far & setbacks
- iii. Casual decision for foundation
- iv. Casual decision of plinth level
- v. Improper construction of wall
- vi. Construction joint between old/new wall and dissimilar structure.
- vii. Defective RCC work.
- viii. Improper slope of floors in rooms and bathrooms
- ix. Cracks in the plastering.
- x. Breakage of wall & plastering by installation of electrical insulation.
- xi. Improper drainage and sewage line.
- xii. Defects in wooden doors, window and ventilators.

V. SUMMARY

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