CIRCEA's Annual Risk Management Seminar 2018
Forensic Engineering: Expert Evidence

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Engineers Australia

8 Thomas Street, Chatswood

Dilapidation surveys – Issues & pitfalls

Part-1:

"Documentation techniques, measurement and photography."

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Background

A dilapidation survey is an inspection, normally undertaken on behalf of a person or company intending to demolition, construct or development a site, of the existing general and structural condition of surrounding properties, buildings and structures before commencement of the development.

- **Dilapidation surveys need to be undertaken by an appropriately qualified and experienced professional(s) as there may be a subsequent claim against the Developer, a court action and the need to assess an appropriate quantum.**

- **While Councils' DA requirements often stipulate the need for a dilapidation survey to be undertaken by a Developer, in my opinion, the Developer should always undertake a dilapidation survey as part of his Risk Management and total development cost contingency budget.**

Depending on:

- **the proximity of adjacent buildings and structures to the boundaries of the development site,**
- **the development's proposed depth of excavation, and**
- **the foundation conditions (including groundwater levels),**

the developer's project design team (Civil/Structural engineer and Geotechnical engineer in particular) normally require detailed information on the structural form / condition / footing type(s) and founding levels of adjacent buildings and structures in particular.

Note that:

- **Such information is also critical in determining the type of excavation equipment that can be used on-site generally and near the site's boundaries in particular, i.e. the amount of energy that can be imparted to the foundations so as to limit the peak particle velocity at the site's boundary and/or the nearest face of the adjacent structure.**

- **The Developer may choose to undertake a post-construction dilapidation / condition / comparative survey of the adjacent properties after the end of construction or only of those properties which lodge a claim for damages.**

In my opinion, the potential issue of locked-in stresses in masonry and other building materials presents a risk factor to both the Developer and the adjacent property owner(s) as:

- **pre-existing locked-in stresses may only need a minimal increase from construction activities to result in visible cracking, and/or**
- **locked-in stresses as a consequence of the development works may:**
  - **result in almost immediate cracking, and/or**
  - **become evident with time due to additional loading that had otherwise not caused an issue (wind, minor earthquake, vibration transfer from heavy vehicles on adjacent, uneven road surfaces).**

Co-ordination and Timing Considerations

Co-ordination and logistical considerations are an ever-present issue for a professional undertaking a dilapidation survey when the development site is surrounded by medium and/or high-rise apartments.

Whenever possible, might I suggest others be responsible for obtaining access approval and setting dates and inspection times based on your experience and availability.

Check parking availability.

The time from appointment to delivery of the dilapidation survey should preferably allow for investigation time to obtain some local area knowledge and request potential plans / elevations of properties to be inspected.

However, some of this background information may already be available from the projects civil/structural and geotechnical engineers.

Documentation

- **While I believe many appropriately qualified and experienced professionals have the knowledge to undertake a thorough dilapidation survey, the Client's brief may be somewhat restrictive due to time allowed, financial constraints and/or the Client's decision to accept a less extensive survey and carry a larger, project risk budget.**

- **Obviously, the professional's dilapidation survey should list any imposed constraints, those areas / elements not inspected and normal report limitation clauses.**

- **Dilapidation surveys are a non-invasive, walk-through style inspection with no or minimal temporary shifting of stored items / furniture within a room or space undertaken.**

- **Normal Work Health & Safety requirements must be followed when working at heights.**

As the pre-construction and post-construction dilapidation reports serve as the Developer's basis of defense and/or minimization of quantum against claims for damages, such reports need to contain:

- **appropriately documented evidence of the property's condition by way of –**
- **measurements (crack mapping and crack width measurements),**
- **recording of any apparent floor level issues (laser level),**
- **photographic records (photos, videos of lack of maintenance, wear-and-tear, defects and/or their absence), and**
- **plans / elevations (where possible) to aid in identifying the location of defects and even crack mapping.**

- **It may also be appropriate to engage the services of a registered surveyor to set-up a permanent datum level away from the Development's influence and record a number of base levels on adjoining properties (paving, a reference floor level, top of retaining walls) and verticality of the façades.**

- **Dilapidation reports need to be issued and signed off by the report's writer, the Developer / Client and the property owner / share holder.**

Site Inspection Notes and Forms

- **It is imperative that accurate records be prepared during the course of the inspection and filed.**

- **Such records may be called upon in a Court action to substantiate various items within the report where an explanation may inadvertently be lacking, or another photo (not included in the report but used to form an opinion) could clarify the matter.**

- **To simplify the time-consumer and often repetitive inspection tasks, it is necessary to prepare / have a selection of spreadsheet-based forms or checklists to remind you of what ‘standard’ items you wish to include, to allow rapid entry of data (hardcopy or direct, tablet input) and ensure pertinent measurements and/or photos are not missed.**

Measurements

- **Where needed for reporting purposes, general measurements are undertaken with a laser distance measuring device such as a Leica Disto (which can also be used to determine other approximate building dimensions with built-in software), 30 m steel tape, 25 mm wide 8 metre builder's tape or 2 metre "Minirod".**
- **The Minirod has standard millimetre and centimetre increments on one side and alternating red and white 5 mm increments on the reverse side which are clear graduations when the tape is included in a photograph for purposes of scale or actual measurement.**

- **Rapid initial checks on floor levels, cantilever tip deflections and vertical step issues are possible with a laser level. Such a device can also provide information, if needed, on verticality of room scale building elements.**

- **Nevertheless, there will be times when the services of a Registered Surveyor are required.**

Crack width measurement

There are a number of tools available for the measurement of cracks:

- **the most common and practical being a crack comparator card (may be see-through or solid)**
- **a hand-held microscope / crack optical comparator (not practical for a dilapidation survey)**
- **a digital caliper (Mitutoyo “Digimatic”)**
- **feeler gauges (not recommended as cracks rarely have a straight, parallel-sided form)**

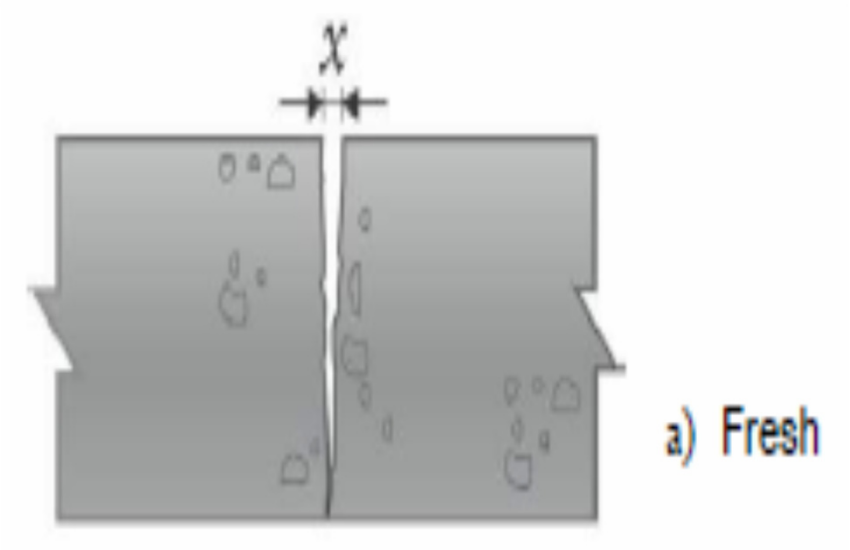
- **Crack measurement involves the recording of cracks at the material's surface (e.g. concrete slabs [top and soffit], clay brickwork or concrete blockwork masonry walls) to provide a descriptive record which can be complemented with photographs to help identify the likely cause(s) of the cracks.**

It is good practice (although time consuming) to record the following:

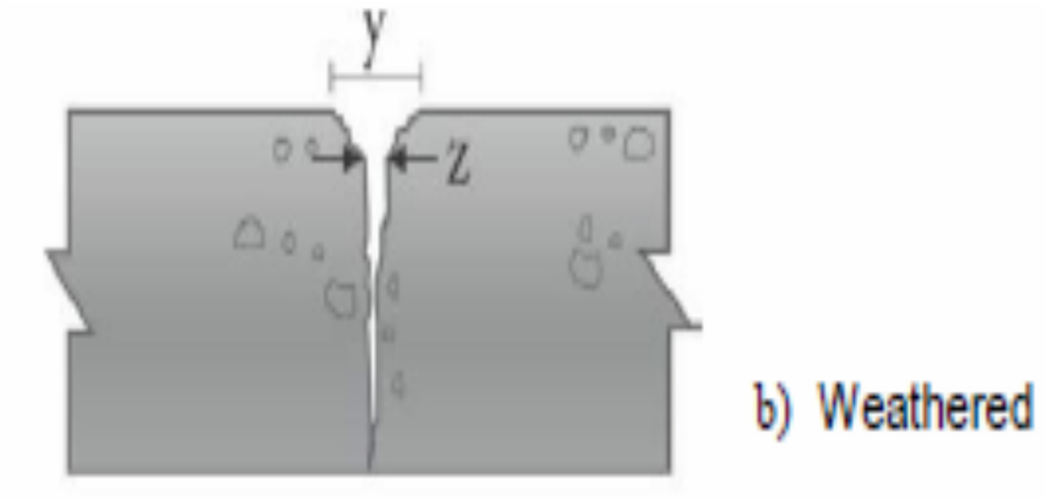
- **the pattern of cracking (yield line, flexural, restraint, differential shrinkage),**
- **orientation with respect to reinforcement (rebars typically orthogonal) and openings,**
- **the location of the cracking in concrete slabs (relative to loadbearing walls under) and on cantilevered slabs (longitudinal flexural cracks on upper surface parallel to the support wall under and transverse shrinkage and thermal stresses through the slab),**

- **The location of external cracks in cavity masonry construction (lack of appropriately located vertical and horizontal control joints)**
- **spacing of the cracks,**
- **length of the cracks,**
- **number of cracks,**
- **concrete surface condition and crack width.**

- **Where a crack appears to be recent or fresh, the crack width dimension would be “X” as in figure (a) below, i.e. at the surface.**



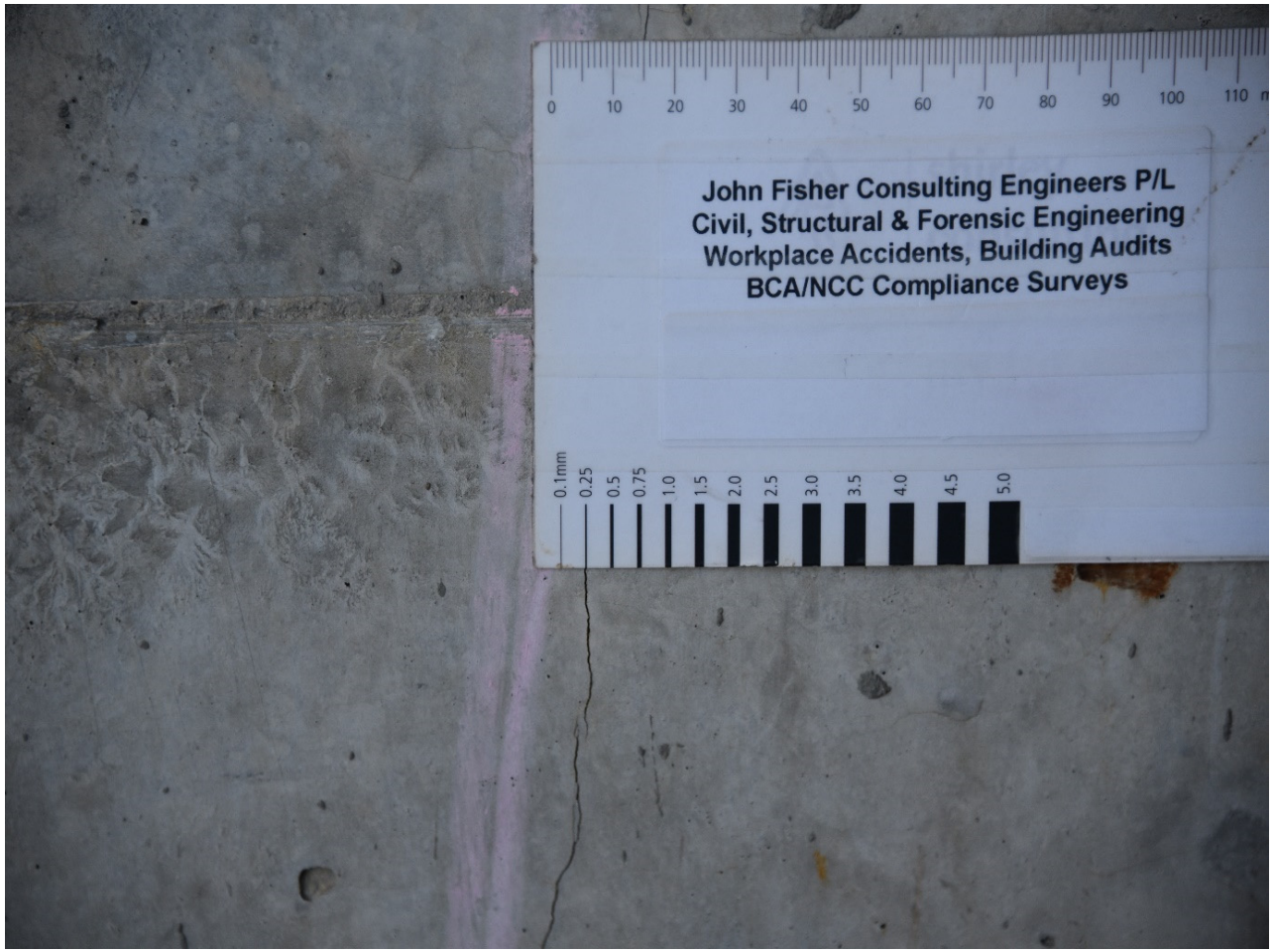
- **If the crack is not recent, it may be weathered or trafficked at the surface thereby exaggerating the width by a significant amount; compare “Y” and the correct crack dimension to record, “Z”, in figure (b) below.**



- **Crack width measurements should be taken at several locations along the length of a crack. The number of readings will obviously be a function of the crack length. General consensus is measurement at metre intervals with a minimum of two.**

- **The inclusion of a tape laid on a horizontal surface or affixed by blue-tac to a vertical or inclined element (or held by an assistant), is good practice when taking photos. My practice is to take a general area shot to identify location, then follow with a close-up and/or subsequent photos as necessary.**

- **When using a crack width comparator card or gauge, ensure that the photo is taken directly over the crack to avoid potential parallax errors, especially where the comparator card is not lying flat and/or close to the surface with the crack.**


0 10 20 30 40 50 60 70 80 90 100 110
John Fisher Consulting Engineers P/L
Civil, Structural & Forensic Engineering
Workplace Accidents, Building Audits
BCA/NCC Compliance Surveys
0.1mm 0.25 0.5 0.75 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0


0.1mm
0.25
0.5
0.75
1.0
1.5
2.0
2.5
3.0
3.5
4.0

- **Example of crack width comparator not lying flat against the crack.**
- **Subsequent use of the crack width comparator on the screen image (3x magnification) allowed for confirmation of the nominal crack width at 0.5 mm.**

Classification of cracks for reporting purposes

- **The classification of cracks in walls and concrete slabs are frequently described as per AS 2870-2011 – Residential slabs and footings, Appendix C – Classification of damage due to foundation movements (Normative), Tables C1 and C2 respectively. These tables relate a range of crack width to a five-tier "Damage category" of zero to 4.**

- **Note that while both tables have the same Damage categories and associated description, the approximate crack width limits within each Damage category vary for walls and slabs.**

- **The use of the prefix “DC” before the category number is a JFCE modification to better describe the category for report purposes.**

Table C1 - Classification of Damage with Reference to Walls

Description of typical damage and required repair	**Approximate crack width limit (see Note 3)**	**Damage Category [DC0 to DC4] *(damage degree)#***
Hairline cracks	< 0.1 mm	DC0 *(negligible)*
Fine cracks which do not need repair	< 1.0 mm	DC1 *(very slight)*
Cracks noticeable but easily filled. Doors and windows stick slightly	< 5.0 mm	DC2 *(slight)*
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weather tightness often impaired.	5 mm to 15 mm (or a number of cracks 3 mm or more in one group)	DC3 *(moderate)*
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted.	15 mm to 25 mm but also depends on number of cracks	DC4 *(severe)*

Table C2 - Classification of Damage with Reference to Concrete Floors

Description of typical damage	**Approximate crack width limit in floor**	**Change in offset from a 3 m straight edge centred over defect (see Note 6)**	**Damage Category [DC0 to DC4] *(damage degree)#***
Hairline cracks, insignificant movement of slab from level	< 0.3 mm	< 8 mm	DC0 *(negligible)*
Fine but noticeable cracks. Slab reasonably level.	< 1.0 mm	< 10 mm	DC1 *(very slight)*
Distinct cracks. Slab noticeably curved or changed in level.	< 2.0 mm	< 15 mm	DC2 *(slight)*
Wide cracks. Obvious curvature or change in level.	2 mm to 4 mm	15 mm to 25 mm	DC3 *(moderate)*
Gaps in slab. Disturbing curvature or change in level.	4 mm to 10 mm	➢ 25 mm	DC4 *(severe)*

The 2010 UK Concrete Society publication, TR22 – Non-structural cracks in concrete (2nd edition [now 4th edition]) gives the following classification of cracks by separating cracks into two classes:

1. Dormant cracks which are unlikely to open, close or extend further. These cracks are subdivided as follows:

- **Fine cracks: <0.5 mm wide**
- **Medium cracks: 0.5 to 1.5 mm wide**
- **Wide cracks: >1.5 mm wide**

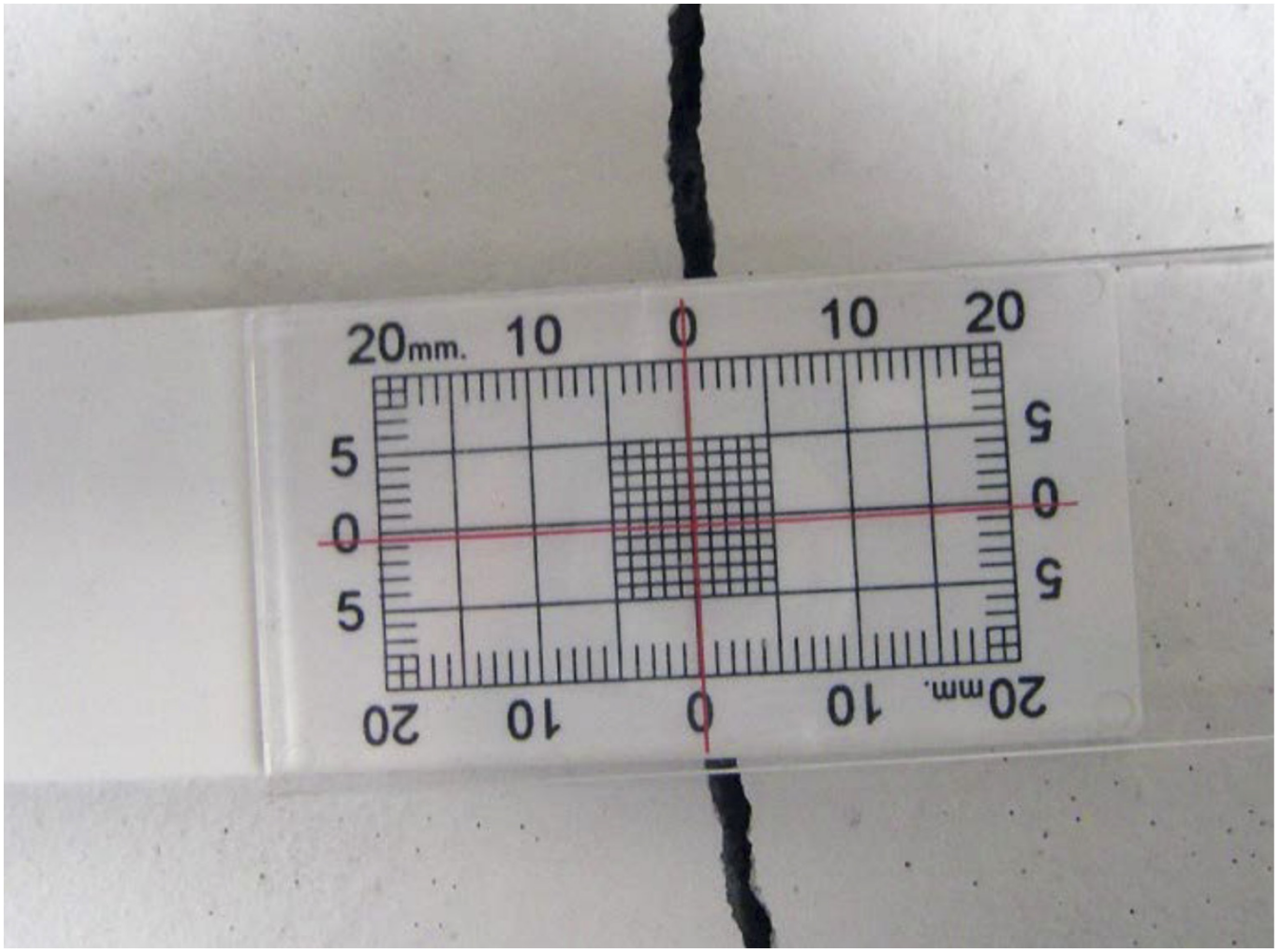
(In practice, it is likely that few cracks will be fully dormant.)

2. Live cracks which may be subject to further movement due to changes in the concrete temperature and/or moisture state, loading etc.

Measuring movement of cracks

It may be necessary to assess if a crack is still moving, e.g. due to foundation/ footing differential movements, ambient temperature changes, shrinkage, or even early thermal contraction.

This may be done by using simple “tell-tales” bonded across the crack; this will show if further movement takes place.


20mm. 10 0 10 20
5
0
5
20 10 0 10 20mm.

- **While it is unlikely to be part of a pre-construction dilapidation survey, sophisticated electronic devices for measuring movements are available with the ability for recorded data to be sent back to your office.**

- **While visual clues may indicate dampness issues, even surface penetration prongs of testing devices may not be appropriate, although subsurface conditions can be assessed without the use of probes.**

Photography for dilapidation surveys

- **Always undertake an inspection with more than one camera.**
- **A small camera is often required for taking photos through small openings and tight locations.**
- **Whenever possible, download images to laptop before leaving site.**

- **Ensure the flash has a long range (important for roof void photos).**

- **Need a lens capable of close-up / wide-angle work and also capable of high magnification (say, 28 to 300 mm) for surveying facades from ground level or adjacent / opposite premises (a doubler-lens facility also helps).**

- **A good pair of binoculars.**

- **Even though the images are digital, a date on the photo is convenient.**

- **Take extra photos, you may not get access again and when you are back in the office it's too late.**

- **Have two strong torches for the inspection(s).**

Thank you for listening.

Topic related references:

- **AS 4349.0-2007 Inspection of buildings Part 0: General requirements**
- **AS 4349.3-2010 (1998) Inspection of buildings Part 3: Timber pest inspections**
- **AS 4349.2-2018 (2007/1995) Inspection of buildings Part 2: Group titled properties**
- **AS 4349.1-2007 (1995) Inspection of buildings Part 1: Pre-purchase inspections—Residential buildings**