



Insight

Non-Destructive Testing and Condition Monitoring

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*Special Feature:
NDT in Civil Engineering*



Testing times for building managers

Michael Nugent, Principal Consultant with the Concrete and Corrosion Consultancy Practice - a new BINDT Associate Member Company, explores the argument for condition surveys and inspection/testing.

There are several valid reasons for carrying out inspection and testing/condition surveys to all types of buildings and structures. The value of these surveys is the same, whether the building be brick, concrete, steel, clad, or indeed another type of structure altogether, for example, bridges, tunnels etc.

Safety

Safety is always the prime concern of all involved with the building or structure. Very often, buildings and structures suffer from spalling of one kind or another. Where there are public areas below façade elevations this can give rise for genuine concern.

When talking of spalls, most tend to think of reinforced concrete affected by expansive corrosion and in some respects this is the most severe, as large pieces of concrete obviously present a potentially fatal threat - yet there are other dangers with all types of façade, including corroded steel sections, defective brickwork and pointing, cladding fixings, panels etc.

With Health and Safety legislation being so stringent and affecting both companies and individuals alike, it is obviously important to be seen to implement at the very least 'make safe' measures, sometimes referred to as 'holding measures'.

Maintenance

A detailed condition survey can yield vital information that can greatly reduce the risk of escalating costs during a repair project due to unforeseen defects. Quality surveys will typically include:

- Visual appraisal
- Photographic support
- Defect marked drawings
- Testing data
- On-site data record sheets
- Conclusion/recommendations
- Budget rated bills of quantities

Asset management

Inspection and testing are valuable tools in producing planned maintenance and life-cycle costings, as well as fitness for purpose. This is extremely important when managing a property portfolio and requiring accurate future funding requirements.

Where to get the best service

This subject has long been a political minefield. There are many organisations in the marketplace offering surveys - some on a fee basis and some free of charge. Material and system manufacturers often offer survey services, as do contracting companies either as

The writer would welcome discussion on the contents or inspection and testing in general and can be contacted at: The Concrete and Corrosion Consultancy Practice Limited, Black Barn Court, Hoath Road, Hoath, Nr Canterbury, Kent CT3 4JP. Tel: 01227 860111; Fax: 01227 860110; E-mail: concorr@btinternet.com; website: www.concorr.co.uk



a dedicated service or as part of contract proposals - these should always be viewed as a guide or option alone as they are not in anyway independent and are often part of a hidden marketing tool.

Independent consultants that have no ties to contracting or material companies are always best placed to offer the client truly independent advice based on knowledge of the structure, the survey results and all available systems, regardless of where they come from. Options can be offered with valid reasons based on what is best for the client's requirements rather than being based on what is available in a company's range or contractual financial implications.

Access

Without doubt the most cost-effective and versatile method of access is by industrial roped access techniques. This system allows safe, rapid access to almost all of the areas of a building or structure at a fraction of the cost of other access systems. One benefit is time. For example, a roped access technician can be at the work-face within 30 minutes of arriving on site - scaffold can take weeks, and cradles days.

Using roped access allows the technician to move freely over the façade carrying out detailed survey works - very importantly, at touching distance and making safe as they survey by removing potentially dangerous elements.

Only companies that can demonstrate experience, training and possess the capabilities to prepare detailed method statements, risk assessments and work/rescue procedures should be engaged to carry out roped access surveys.

Other reasons

Very often isolated defects occur on a façade, for example, damaged or leaking joints, cladding panels unsafe etc. require

urgent attention, often the erection of scaffolds would take too long and be cost-prohibitive, so again roped access becomes a fast, cost-effective solution.

Testing concrete - available techniques

There are many techniques available to test and inspect a reinforced concrete structure. A brief description of some of the more commonly used is given below.

Visual appraisal

It is always important to first familiarise yourself with the structure to be surveyed, making notes of obvious defects and any details requiring investigation. A visual record sheet is normally used to record items such as cracks, spalls, stains, reinforcements, tie-wires, etc. These details would then be transferred to drawings and cross-referenced with any photographic support.

Hammer testing

This is widely used as a method of detecting loose concrete and hollow areas. Hammer testing is often described as NDT, even though small indentations are sometimes left and the points of impact. Two methods are commonly used, the first being a general-duty hammer and the second a Schmidt hammer. The Schmidt hammer tends to give misleading results if the user works from the correlation curve supplied with the instrument, as all concrete is not the same. During a hammer test survey, any dangerously loose concrete should be removed to prevent a potential hazard.

Covermeter testing

There are several types of covermeter available, each having its own advantages and disadvantages. All work on the principle that ferromagnetic cores measure the induced current produced when another ferromagnetic object - usually the reinforcement - completes the circuit. It is important for the operator to be experienced and not rely unquestioningly on the results, as many factors can influence the readings of both reinforcement depth and bar size. If possible, expose a section of reinforcement for inspection.



Half cell testing

Half cell testing is used to determine where electrical activity is taking place. An electrical contact is made to the reinforcement and a reference electrode probe is passed over the surface of the concrete. Readings are then taken and recorded over grids of typically 0.5 or 1 m². The output is fed into a computer, which enables plots of potentials to be displaced or printed.

Carbonation tests

Carbonation tests can be carried out by testing a freshly drilled core or the substrate beneath a newly dislodged piece of concrete. The exposed concrete is next sprayed with a suitable indicator solution such as phenolphthalein - the substrate remains colourless on carbonated concrete and turns bright pink on alkaline concrete.



Chloride test

Testing for chloride is generally done in a laboratory, although on-site kits are available. Dust samples are taken at different depths and tested for chloride concentration. Levels greater than 0.4% with respect to cement content suggests reinforcement corrosion will be a problem.

Other tests

There are many other tests available, such as resistivity, ultrasonic pulse velocity, impulse testing and so on. The nature of the structure and the likely deterioration processes will decide which of these, if any, will be needed for proper assessment.

Testing cladding

Cladding and curtain walling takes many forms from marble-effect pre-cast panels to powder-coated aluminium, however the defects requiring attention widely follow the same path:

- How they are fixed
- Condition of the fixing systems
- Damage to the façade
- Potential damage to the structure due to failure

Carrying out condition surveys to such façades is essential but often requires intrusive investigations as well to establish system conformity, design detail and condition of otherwise hidden elements (*ie* fixing details). Always remember - a clad façade may look good but what is going on behind the scenes?

Available techniques

Visual appraisal

Cladding defects need to be accurately recorded. Defects such as missing visible fixings, physical damage, staining caused by the elements, staining and surface damage caused by non-suitable past cleaning attempts are all common occurrences. Less common but still found on a regular basis are panels and trims missing altogether.

Covermeter testing (for reinforced cast panels)

Many pre-cast panels are like a sandwich in construction with concrete to the rear section and the panel finish to the top (near surface) section. Well-designed panels will have reinforcement embedded deep within the rear section, although many are found with the layer of reinforcement between the base backing and the thinner section surface finish - these often require urgent measures to prevent spalling and serious failure.

Ultrasonic coating thickness testing

This technique is used to test a variety of coating thicknesses from

powder coating on metallic cladding panels to anti-carbonation coatings used to protect reinforced, precast concrete panels. The system is totally non-destructive and is valuable for both specification conformity as well as a basis for future required coating maintenance.

Ultrasonic metal thickness testing

Important factors such as cladding weight per square metre, metal thickness of runner and brackets etc. can all be calculated by ultrasonic measurement of metals. The system can also be used for measuring bolts and shaft/tunnel linings.

Endoscopy

This is used to view the condition of a wide variety of panel and brick fixings. Often, the numbers of fixings holding cladding panels in place are found to be in poor condition and less than specified in numbers.

A combination of the above and other techniques, followed by an accurate interpretive report, will identify both the true cause and extent of defects and remedial requirements. In this day and age, still far too many tender documents are being sent out to price with provisional items against important and far-reaching cost implication items such as concrete repairs, when the guess-work (educated as it may be) can be removed. The philosophy could be summarised as: 'why park an ambulance at the bottom of a cliff waiting for someone to fall when you could always repair the fence at the top!'

A relatively small outlay prior to the contract having a survey carried out will, almost without exception, save large costs and help achieve a smooth contract without unpleasant surprises.

Enquiry No 107-15

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