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LIMITED

Building Inspection and Testing

HRS SERVICES LTD. THE MALTINGS. BURTON ROAD. SHEFFIELD.S3 8BZ | Tel: 0800 030 4391 | www.hrsservices.co.uk | email: info@hrsservices.co.uk
LINK-UP APPROVED . DIRECTORS S E WESTGATE MPhil BSc MCIOB P T WESTGATE BSc Dip Min Eng . REGISTERED NUMBER 2115177 (WALES) . VAT NO. 440 1069 93

HRS Services Ltd.
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Building Inspection and Testing

HRS carry out a wide range of NDT and inspection techniques to assess the condition of concrete and masonry structures. Concrete is not the all-enduring material it is often thought to be and many poorly designed or constructed structures require considerable maintenance to prolong service life. Structural investigations can include tests to identify poor materials, environmental contamination from road salts, sulphates and carbon dioxide to offer valuable information for the engineer to determine refurbishment cost and project the safe lifespan of the structure.

HRS carry out many inspections of highrise office and residential structures. These often consist of concrete framed structures with either brick infill or precast concrete panels, sometimes with a render finish. Outlined below are some of the building inspection services we can carry out. This is not an exhaustive list, for further detail you can contact us directly and discuss your specific requirements. In all cases the locations at which the testing is carried out are recorded as location markers on elevation drawings within the final inspection report.

Visual Inspection and Hammer Testing

All areas of the building exterior are visually examined at close quarters and details recorded of the general condition and the type, dimensions and location of more specific defects.

All areas of the building exterior are hammer sounded by light tapping or broad sweeps of an inspection hammer across the surface of brick, render or concrete. Particular attention is paid to column edges, beam edges, cracked material, previously repaired areas and areas displaying signs of bulging or displacement. Changes in pitch indicate the presence of spalling material or badly adhered render/slip bricks.

Spalling in concrete typically occurs as a result of moisture reaching the underlying reinforcing bar via minor cracking and porosity, subsequent corrosion then forcing off the surface material. Another cause may be salt spalling, this is a specific type of weathering which occurs in porous building materials. Dissolved salt is carried through the material in water and crystalises near the surface as the water evaporates. As the salt crystals expand this builds up shear stresses which break away spall from the surface.

Hammer sounding can detect spalling at an early stage allowing the building owner to act in time to prevent material falling from height.

Details of the visual inspection and hammer testing are presented in a schedule of defects within the final inspection report.

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Concrete Chemical Testing

HRS are frequently asked to carry out a range of non destructive tests to structural concrete. Below are details of the most commonly requested tests.

- Carbonation

Carbonation is an important form of deterioration. On the one hand carbonation gives concrete the immediate positive effects of increased; compressive strength, modulus of elasticity, surface hardness, and resistance to frost and sulphate attack. However, more importantly, it reduces the alkalinity of the concrete which leads to the corrosion of the reinforcing steel. The increased volume of the resulting corrosion spalling, delamination and the ultimate reduction of the structure's capacity.

Calcium hydroxide, Ca(OH)2 , is formed during cement hydration, and because of the high alkalinity of calcium hydroxide, the presence of calcium hydroxide will ensure a high pH-value in the concrete. The pH-value is roughly constant, as long as calcium hydroxide is present, regardless of the specific content.

During the carbonation process, calcium hydroxide reacts with carbon dioxide, CO2, from the atmosphere. When all calcium hydroxide in an area has reacted, the pH-value in the area drops. Testing is undertaken by applying a phenolphthalein solution to a freshly exposed surface of concrete, noncarbonated areas turn red or purple while carbonated areas remain colourless. The phenolphthalein indicator changes colour at a pH of 9.0 to 9.5. The pH of good quality noncarbonated concrete is usually greater than 12.5.

Carbonation is time-dependent. Carbonation generally tended to be greatest on the south side and least on the north side. The presence of carbon dioxide from vehicle exhaust corresponded to levels of carbonation, thus carbonation rates are often found to be higher at the bottom of high-rise structures than at higher elevations. Sometimes exceptions to this may occur at higher levels were carbonation can be caused by the presence of a rooftop exhaust outlets.

- Cover Depth

Not a chemical test but detailed here due to it's direct relationship to the carbonation testing. Adequate cover to the steel reinforcement in a structure is important to ensure the steel is maintained at sufficient depth into the concrete to be well clear of the effects of carbonation or aggressive chemicals. HRS use covermeters to carry out non-destructive checking of steel reinforcement depth. The use of covermeters together with requirements for accuracy is contained within British Standard 1881: Part 204.

The presence of reinforcement in concrete can be detected by the influence that reinforcing steel has upon an electromagnetic field generated by the covermeter. The covermeter operates by inducing an eddy current in the reinforcing steel, secondary coils in the covermeter survey head detects these eddy currents enabling position, and an estimation of depth and bar diameter to be made.

The position and direction of steel reinforcement is determined by moving the search head of the covermeter over the surface of the structure until the meter shows a maximum deflection. If the concrete cover is known, the maximum deflection reading can be used to assess the diameter of the reinforcement bar.

Covermeter readings assessed in comparison to carbonation depth provide an indication of the safe lifespan of an area of concrete.

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- Chloride Content

Chloride ions when present in reinforced concrete can cause very severe corrosion of the steel reinforcement. The chloride ions will eventually reach the steel and then accumulate to beyond a certain concentration level, at which point the protective film around the steel is destroyed and corrosion will occur if oxygen and moisture are present in the steel-concrete interface. Chlorides usually originate from two main sources: a. Chloride added to the concrete at the time of mixing, often referred to as internal chloride. This category includes calcium chloride accelerators for rapid hardening concrete, salt contaminated aggregates and the use of sea water or other saline contaminated water. b. Chloride ingress into the concrete from the environment often referred to as external chloride. This category includes both de-icing salt as applied to many highway structures and marine salt, in the form of air-borne salt spray in structures adjacent to the coast.

The effect of chloride salts depends to some extent on the method of addition. If the chloride is added at the time of mixing, the calcium aluminate (C3A) within the cement paste will react with the chloride to some extent, chemically binding it to form calcium chloroaluminate. In this form, the chloride is insoluble and is not available to take part in damaging corrosion reactions. The ability of the cement to chemically react with the chloride is however limited and depends on the type of cement. Sulphate resisting cement, for example, has a low C3A content and is therefore less able to react with the chlorides. Experience suggests that if the chloride exceeds about 0.4% by mass of cement, the risk of corrosion increases. This does not automatically mean that concretes with chloride levels higher than this are likely to suffer severe reinforcement corrosion: this depends on the permeability of the concrete and on the depth of carbonation in relation to the cover provided to the steel reinforcement.

When the concrete carbonates, by reaction with atmospheric carbon dioxide, the bound chlorides are released. In effect this provides a higher concentration of soluble chloride immediately in front of the carbonation zone. Normal diffusion processes then cause the chloride to migrate into the concrete. This process, and normal transport of chlorides caused by water soaking into the concrete surface, is responsible for the effect sometimes observed where the chloride level is low at the surface, but increases to a peak a short distance into the concrete (usually just in front of the carbonation zone). The increase in unbound chloride means that more is available to take part in corrosion reactions, so the combined effects of carbonation and chloride are worse than either effect alone.

The depth/concentration profile for external chloride, which has penetrated hardened concrete, will show levels decreasing further from the surface. Chlorides present in the fresh concrete will tend to be evenly distributed throughout the concrete.

Passivation of the steel reinforcement in concrete normally occurs due to a two component system comprising a portlandite layer and a thin pH stabilised iron oxide/hydroxide film on the metal surface. When chloride ions are present, the passivity of the system is lost by dissolution of the portlandite layer, followed by debonding of the passive film. Physical processes operating inside the passive film may also contribute to its disruption.
Chloride content is determined by collection of concrete dust samples at various depth and locations. These are sent off for analysis by a specialist test lab. The results of this analysis are presented within the appendices of the inspection report.

- Other Chemical Tests

Less frequently HRS are also asked to carry out further tests including:

- Sulphate content
- High Alumina Cement
- Concrete compressive strength
- Alkali Silica Reaction

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- Wall Tie Investigation and Borescoping

External walls to most buildings constructed after 1920 are cavity walls. Typically there is an outer leaf of 100mm thick brickwork, a 50mm wide cavity, and an inner leaf of 100mm thick blockwork. The outer and inner leaves are tied together with wall ties. Wall ties are usually 900mm apart horizontally and 450mm vertically. They are usually galvanised steel. It should be noted that older ties often had a relatively thin layer of galvanising, not adequate to stop the steel corroding. This type of wall construction is one commonly encountered by HRS on high rise structures.
There are two problems with corroding wall ties. The ties can corrode in the cavity and break such that the outer and inner leaves are no longer tied together. If this occurs, there is a distinct risk of the outer leaf collapsing, especially under high winds which cause suction on the face of the wall.
The more common problem is when the part of the tie embedded in the outer leaf corrodes. This tends to occur on south and west facing elevations which are exposed to driving rain and which are often wet. Rust occupies a greater volume than the original steel and therefore the expansion of the tie in the bed joint forces it to crack. Cracks running along the bed joints, every 450mm up the wall, are a strong indication of wall tie corrosion.
A wall tie survey comprises detecting the locations of wall ties using a metal detector (Impedance meter), and then drilling a small hole and using an borescope to examine their condition. Surveys can be carried out on sample panels or across the whole building. Our report includes wall tie location maps of panels examined. A separate table is included detailing the findings of the bore-scope examination, this includes type, number, condition, depth of cavity and cavity condition. Where possible, photographs are taken using the borescope showing wall ties in-situ. In some instances the cavities are found to be blocked with debris or insulation material, in these cases it is not usually possible to carry out a detailed visual inspection of the ties/cavity or produce useful images.

- Brick Out Examination

Brick-outs are carried out by HRS in order to examine the support detail where a brick panel is supported by the concrete floor deck.

A brick is removed from the first course of bricks above slab level on different floors of a structure. A visual examination is conducted and records made of cavity width, condition, support details, damp proof course details and condition. Photographs are taken and included in the final inspection report. A cross sectional drawing is produced illustrating the structural details found. A separate table showing relevant dimensions is produced. All brickout locations are subsequently made good to suit the existing building.

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Contact Us

Should you require any further information, please do not hesitate to contact us.

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